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Swedish University of Agricultural Sciences

Faculty of Natural Resources and
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A Critical Perspective on Ecological Unequal Exchange, Dependency and Development: the case of Chile

Alberto Isakson

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Alberto Isakson

Supervisor: Cristián Alarcón-Ferrari, Swedish University of Agricultural Sciences, Department of Urban and Rural Development.

Examiner: Hans Peter, Swedish University of Agricultural Sciences, Department of Urban and Rural Development.

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Abstract

Chile is strongly interconnected to the global markets through its trade relations. From a monetary perspective the country has shown an outstanding trade performance, having an equilibrated trade balance, avoiding debts and even presenting periods with high surplus. Nonetheless, the products Chile trade have embodied great social and ecological impacts. Thus, from a social and ecological perspective, Chile's positive trade performance is being challenged. Ecological Unequal Exchange (EUE) is a theory that precisely analyses these dimensions in trade. However, EUE has several limitations that must be discussed and overpassed. This thesis, through a deep theoretical discussion and a detailed empirical study on Chile's trade relations between 1960 and 2014, builds a critical analysis to EUE theory and its accuracy in explaining the issues related to trade and its consequences for the trading countries. This study concludes that depending on the EUE approach used, Chile can have or not have EUE relations. Furthermore, this thesis shows that *strict-approaches* to EUE fall short in explaining the complex interactions and consequences of trade. Therefore, a *critical* or *relative-EUE* approach is proposed, emphasising the impacts *global relations has on local realities* to understand the consequences of trade and achieve a more sustainable development.

Keywords: Ecological Unequal Exchange, Sustainable Development, Development, Political Ecology, International Trade, Chile, Dependency Theory, Interdependency.

Popular Summary

Globalization has connected countries through trade to unprecedented levels. Chile is not the exception, and the country is tightly connected to the world markets. In fact Chile is one of the countries with most free trade agreements signed (covering more than 60 countries). From a mainstream economic or monetary perspective, Chile has shown during the last 50 years an outstanding trade performance. The country has increased and diversified its export products following its competitive advantages (raw materials), has had an equilibrated trade balance (its income from exports is similar to the expenditure in imports), thus, avoiding debts and even presenting periods with high surplus. The Neoclassic economic school (mainstream) has promoted trade as a mechanism to develop and thus catch up with developed countries. Nevertheless, despite Chile's positive trade performance, Chile has still not reached the income levels of a developed country yet. In fact the income gap is increasing, meaning that international inequalities are widening. Furthermore, Chile's trade has great socio-environmental impacts embodied, which are not considered in the mainstream analysis. Examples of these impacts are water and soil pollution from mine industries, intensive water use in forestry industry affecting agricultural communities depending on those resources. When Chile exports mine and forestry resources, in parallel the country is exporting those socio-environmental impacts embodied on the resources. Therefore, Chile's trade performance and the economic theory supporting it (neoclassical) are being challenged.

This thesis analyses Chile's trade, not from a monetary perspective, but rather from a social and environmental approach, exploring how those dimensions can affect Chile's development experience. The theory chosen to study trade from a socio-environmental perspective is called Ecological Unequal Exchange (EUE), and focus on analysing the asymmetrical flow of nature (biophysical values) and social impacts between countries. Furthermore, this thesis will critically analyse how accurate is EUE theory to explain the consequences of Chile's trade. The focus is on Chile's trade relations between 1960 and 2014 (with special emphasis in the period 2000-2014). Quantitative methods are used through case studies regarding pollution episodes and its impacts on local communities, and a statistical analysis on Chile's biophysical trade flow.

This thesis concludes that the strict-EUE approach, which is used by most authors, has several limitations in explaining how countries impact each other and what consequences it has. Furthermore, this study shows that depending on which EUE approach is used, Chile can be considered to have or not have EUE relations. Contrary to the strict-EUE approach, this study shows that all trade partners simultaneously benefits and keeps negative impacts of trade. However, the distribution of benefits and impacts are extremely uneven inside Chile. Therefore, a class analysis is needed to understand how EUE occurs and its consequences. This thesis also shows that trade relations, through transforming local communities' nature and socio-economic realities, are challenging their development. Finally, this thesis concludes that analysing the impacts *global relations has on local realities* is essential to understand EUE and to achieve a more sustainable development.

Keywords: Ecological Unequal Exchange, Sustainable Development, Development, Political Ecology, International Trade, Chile, Dependency Theory, Interdependency.

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1. Introduction

Since the XXth century the market economy has globalized to unprecedented levels in human history, and at the present only few countries remain disconnected to it. According to several authors what we understand today as *globalization* could be considered as a natural consequence of the market system, i.e. of capitalism (Marx, 2010; Luxemburgo, 2003; Moore, 2013). The system would expand in pursuit of energy, raw materials, food and labour sources, and to open new markets to invest and sell its products. Therefore, low or un-capitalized countries would be the main target. Until the mid-XXth century this expansion took in many cases the form of invasions and colonisations; while in parallel, the world started being divided progressively in *centres* (rich and developed countries) and *peripheries* (poor and less developed countries). At the present those practices have been left behind and replaced by policies to open countries to international trade and then strengthen those trade relations. However, the hierarchy of *centres* and *peripheries* has been maintained. Furthermore, trade is not only the transfer of products and monetary values between countries, but trade has several hidden costs. On one hand the products traded in the global markets have several social and environmental impacts embodied, which are originated during their production processes (e.g. pollution, environmental degradation, or bad working conditions). And on the other hand those products also represent *nature* or biophysical values (as amount of water, land or CO_2 needed to produce them). I.e. indirectly in international trade socio-environmental impacts and *nature* are being exchanged. Ecological Unequal Exchange (EUE) is a theory that precisely analyses how those dimensions are being transferred in the global economy. When the transfer of those *nature* and impacts is uneven countries are considered to be having Ecological Unequal Exchange relations (Rice, 2007; Moran et, al., 2013; Dorninger and Hornborg, 2015), and according to the theory, EUE would benefit the *centres* in detriment of the *peripheries,* hindering the lasts' possibilities to economically develop and catch up with the wealthy nations.

Despite being located in one of the most southern parts of the world, Chile is strongly integrated to the global economy through its trade relations. This integration has progressively increased under the neoliberal policies implemented in the country since the 1970s. At the present Chile has free trade agreements with more than 60 countries, and in February 2016 the country signed the Trans-Pacific Partnership (TPP) aiming to strengthen its trade relations even more. There is no doubt that trade has brought benefits for Chile, as the possibility to consume products that are not produced in the country. Nevertheless, it has also produced severe costs that the country has put little attention on. Chile exports mainly raw materials as iron, copper and wood products, which have embodied huge socio-environmental impacts in their production. For example: air and land pollution, tailing dam spills, deforestation, resource depletion, greenhouse gas emissions, labour exploitation, poverty and social inequality. These impacts open the possibility to suspect that may be Chile is being affected by an *Ecological Unequal Exchange*. Nevertheless, Chile is also importing socio-environmental impacts from other countries, as for example pollution from fossil fuel extraction in the USA or bad working conditions in some Chinese manufacturer factories. Therefore the Ecological Unequal Exchange relation is not obvious, but needs to be analysed more carefully.

This thesis, through a theoretical discussion and an empirical study of Chile's trade, analyses whether Chile is having or not an Ecological Unequal Exchange, exploring how that EUE occurs, and how it can be impacting Chile's economic development. Furthermore, this thesis is a critical

analysis on Ecological Unequal Exchange theory, and discusses the theory's accuracy to explain Chile's trade relations and its consequences for the country.

1.1. Objectives

The objective of this thesis is to critically analyse how accurate Ecological Unequal Exchange theory (EUE) is in explaining the uneven transfers of socio-environmental impacts and *nature* between countries, as well as the consequences of that trade. Furthermore, the aim of this thesis is to make a contribution to EUE theory, through making a critical discussion of the theory and applying it to the empirical case study on Chile's trade.

With this thesis I also expect to contribute to the academic discussion between Dorninger and Hornborg (2015) with Moran et. al., (2013) regarding *if ecological unequal exchange does occur,* and expand this discussion to *how Ecological Unequal Exchange occurs*. The discussion between the authors will be explained in the literature review.

This study also aims to explain how Chile is inserted in the global economy from a socio-environmental perspective, how this position has evolved over time, and what consequences it can be having for the country.

I consider that having a deeper understanding on how nature and society are interconnected to the global economic system is essential to promote the construction of a Sustainable Development, which is the final purpose of this thesis.

1.2. Research Process

These objectives will be fulfilled through three main steps:

1. First, a critical Ecological Unequal Exchange framework will be built based on a deep literature review of EUE theory, its evolution and its main critiques.
2. Second, a detailed empirical study will be carried regarding Chile's trade evolution since the 1960s and its socio-environmental impacts, to prove (or not) EUE for the country. The empirical study will focus especially in statistics regarding Chile's trade with its principal trade partners between 2000 and 2014 (USA, China and Japan). And the socio-environmental impacts will be approached as case studies.
3. Finally, the empirical results will be critically analysed under the scope of the conceptual framework, and based on it the research questions will be answered.

1.3. Research Questions

To fulfil these objectives, I have defined three research questions which will serve as guide for the thesis and the discussion:

1. ***Does Ecological Unequal Exchange occur for the case of Chile?***
2. ***How accurate is Ecological Unequal Exchange Theory to explain the transfer of socio-environmental impacts between countries and its consequences?***
3. ***How does Ecological Unequal Exchange occur, and how does it interplay with development?***

2. Literature Review and Conceptual Framework

In this section I will present the literature review and discuss *what Ecological Unequal Exchange (EUE) is*, *what its purpose is, and where the concept comes from*. As I will show, EUE is not a completely unified theory, but there are approaches with some differences. Based on the discussion of the literature review I will build the EUE framework to be used analysing Chile's trade and to answer my research questions.

2.1. What is Ecological Unequal Exchange?

EUE is a theory that explores the asymmetrical transfers of biophysical resources and socio-environmental impacts in trade between rich (developed, *centre, core*) and poor countries (undeveloped, *periphery*). EUE analyses socio-environmental injustices in the global capitalist system, and pursues the understanding of inequalities between countries.

EUE is a critique to the conventional (mainstream) ideas ruling international trade. I.e. to the *comparative advantages theory* (see 2.2.1. Classical Liberal Tradition), which states the exchange relation will be beneficial for all trade partners. Through trading poor countries would progressively economically develop, and thus catch up with the rich countries. Therefore, trade have been proposed as a key in the development process. Nevertheless, through incorporating social and environmental impacts, EUE challenges these mainstream ideas of the universally positive effects of trade, but suggests there can be countries taking advantage over others. Thus, while some countries would be benefiting, others could be worsening.

In the literature there are several authors discussing EUE. At first sight the approaches seem to be very similar, only with small differences. Nevertheless, after studying them deeper, substantial differences between their conceptions of EUE can be found. One author which I shared many points with is Alf Hornborg. Hornborg (2001, 2003, 2014; and Dorninger and Hornborg, 2015) defines EUE as the asymmetric transfer of biophysical values, benefiting one trade partner in detriment of the other; or as the asymmetrical movement of natural space, or environmental load displacement. This asymmetrical transfer would maintain economic inequalities in the world. Hornborg (2014) criticize mainstream thought regarding the universal benefits of technological innovation (efficiency gain), and the blind faith on technology as the way of solving all socio-environmental problems ("technological optimism"). Instead he states that technology allows the flow and appropriation of embodied nature and labour, and thus it is the mechanism how unequal exchange is materialized (Hornborg, 2014). Thus, he consider that technologies benefits some social units (rich groups) accessing it, in detriment of others (poor groups), because the efficiency gain take place only in some sectors, but through redistributing the resource use to other places. Interestingly, Hornborg suggests that it is not contradictory being a *rich zone* of the planet and having an extractive economic sector (as Canada, Australia or Sweden), categories that some authors (as we will see) define as contradictory. Dorninger and Hornborg (2015) comment the relevance of considering a *chain effect* when measuring EUE, as e.g. the energy a country imports may be used to produce exports. Therefore, the socio-environmental impacts related to the energy extraction should not be accounted on the country that is directly importing it, but should be accounted on the country indirectly importing it embodied in other products (i.e. to its final consumer). A final relevant point is that Hornborg (2001) considers EUE must be interdisciplinary, connecting fields as political ecology, sociology, ecological economics and anthropology to understand the depth of the problem.

From Hornborg I deduced some important points that I will explore in this thesis. EUE could take place between countries, but also between social groups (case of technology). And inside each country, there is diversity (rich countries can have extractive sectors as well). The chain effect is also something I will try to explore for the case of Chile. Regarding the interdisciplinary essence of EUE, it suggests that it is not only important to analyse physical trade (of quantities), but also "non-physical" aspects involved in trade, as social impacts. I will come back to these points building my theoretical framework.

Most authors of EUE I read had a more rigid vision of how biophysical matter and energy are transferred in the global economy *(or how EUE occurs)*. Muradian et al. (2002) describe it as an inverse relation of the *environmental loads* of two trade partners: while one increases (benefits) the other simultaneously decreases (detriments). For Andersson and Lindroth (2001), EUE is a trade imbalance between countries calculated in ecological footprints (the same: one is benefited and the other damaged). Rice (2006, 2007) defines it as the asymmetrical transfer of value embodied on natural resources and energy in the south-north trade leading to degradation and underdevelopment. And Roberts and Parks (2009) considers that Ecological Unequal Exchange is produced because the monetary value of the material flow does not consider its environmental and social cost, locking poor countries into unsustainable patterns in the world-system, and generating a reliance of the developed world on the cheap resources of the undeveloped world.

All authors share the idea of asymmetric transfers between countries. But from these last authors I consider their focus is essentially on physical/quantifiable transfers of nature (matter and energy), and not of social consequences. Other important aspect I found in almost all EUE articles is what I perceived as a dialectical vision between countries: a *centre* (developed, rich) benefiting from a *periphery* (undeveloped, poor). In this dialectic categorization the difference between *extractive* or *productive economies* taken from Bunker (1984) is an important distinction (also in Rice, 2006). Bunker suggests the transformation process of the productive economy (based on the materials received from the extractive economy) would imply developing more complex social and economic processes, which would have a stronger effect on economic development. Thus, the inequalities between both kinds of economies would increase (or in best case be maintained) over time. This is an essential aspect I will explore on this thesis, and is related to *"how" EUE occurs*. But are trade's socio-environmental benefits and costs flowing unidirectional between countries? Or could there be other ways as I inferred from Hornborg (as rich countries also with extractive sectors)?

Bunker (1984) is considered as one of the principal precursors of EUE. He analysed the impacts of resource extraction in the Amazonas, arguing it is needed to put more attention in how trade dynamics impacts the environment and society of the periphery. I consider this point to be essential and is the very key aspect regarding *how EUE occurs*. I think that analysing how *local* societies react and are transformed by a *global* economic activity helps us understanding the deep consequences of trade, how those societies *develop*, and therefore understanding the international inequalities. I will argue for these points later, when I conclude over my theoretical framework.

2.1.1. Consequences of EUE

In the literature, it is possible to find several consequences of Ecological Unequal Exchange.

1. The environmental and social impacts of resource extraction (degradation, resource depletion, etc.) would stay in the *periphery*, while the benefits (its consumption) would be transferred to the *centre*.
2. Thus, the socio-environmental costs would be externalized from the centre to the periphery (Rice, 2007; Jorgenson, 2011), producing a dichotomy: *in the periphery consumption would be low but degradation high, while in the core consumption would be high and degradation is low*. The externalization of costs would produce an *ecological debt* for the rich countries (Robert and Parks, 2009), i.e. the rich countries are using more *nature* than what they can produce in their own countries, and this is taken from poorer countries. Thus, EUE would produce and ecological debt.
3. Although the *monetary trade balance* could be equilibrated, the *material trade balance* could have a deficit, generating an ecological deficit/debt, or disequilibrium in the periphery (Andersson and Lindroth, 2001; Bringezu and Schutz, 2001; and Moran et. al., 2013).
4. As resources are exported, the possibilities of the periphery to use them for its own present of future development are hindered (Rice, 2007; and Jorgenson, 2009).
5. Due to ecological unequal exchange, economic growth in the centre would be disconnected from the biophysical input and output (Moran, 2013) i.e. from extraction and the consequences of nature.
6. Based on this, the Kuznet environmental curve, or the dematerialization of developed economies, would be based on externalizing the environmental load to other places (Fischer-Kowalski and Amann, 2001).
7. Roberts and Parks (2009) consider that through EUE, the developed world would be the responsible of global warming. And as a solution to EUE (and global warming), they point to Prebish's policies of closing international trade towards more autonomous economies.
8. Finally, the ultimate consequence, is that Ecological Unequal Exchange would cause underdevelopment in the periphery (Rice, 2006, 2007), and the perpetration of the centre-periphery hierarchy.

From my perspective all the consequences are very logical considering a world-system divided in a *centre* and *periphery*. Nevertheless, as I will argue further on this thesis, these international roles are too rigid. The idea of a richer countries benefiting on the expense (and in detriment) of poorer countries can and does happen, but there can also be more diversity in international relations. Chile for example is considered and semi-peripheral country (between both opposites), which poses a difficulty in fitting it in a strict international role division. Other point is that if trade would only benefit one partner, trade would simple not exist unless it would be forced. As I expect to show, if we relax these strict views the consequences of EUE would not be completely asymmetrically distributed between countries.

2.1.2. How can Ecological Unequal Exchange be measured and tested empirically?

EUE is understood as an asymmetrical transfer between countries; but, how can we measure it? The first step is to define a unit of measurement, i.e. *what is being transferred?* As will be explained in next section (2.2. The Evolution of the theories behind EUE), EUE evolves from Emmanuel's (1969) Unequal Exchange theory (UE), which is a Marxist explanation of how trade can increase inequalities between countries. UE analysed the asymmetrical flow of *labour value* between

countries (international exploitation). From this start point I identified two important discussions to be analysed in order to determine how to measure EUE. As for EUE the *Ecological* aspect is essential, a first important discussion was how to combine the *ecological* perspective (energy value) with the Marxist tradition of UE (based on labour value). Early precursors discussing the idea of nature being traded can be traced to the XIX century, in the work of the chemist Liebig and in writings of Marx (with concepts as metabolic rift). But regarding combining UE with Ecology, according to Foster and Holleman (2014), an essential step was taken in the late 1980s by Odum who analysed the Energy-Marxist relation. This would represent an important intersection between Marxism and Ecology. Lonergan (1988) also analysed combining UE with energy flows, and concluded that both approaches (labour and energy/Marxist and ecological) are compatible and even overlaps. According to Hornborg (2014) the source of value could be labour theory (Marxist) or land-nature (Physiocrats), or energy/biophysical (ecologic economics), and all would be analytically identical. Hornborg also suggests that values are not relevant at all, but the relevant issue is the material net transfer. What I understand from this discussion is that as the basic idea is *underpaid exchange* (international exploitation) the source of value would not be so relevant, but the key would be the fact of being underpaid.

The second discussion I identified regarding how to measure EUE, is the dichotomy between monetary and biophysical terms. Traditional trade theories (competitive advantages) are based on monetary values, while EUE focus on matter and energy and labour values. Basically, I consider that market prices are incapable of reflecting the *amount of nature* and socio-environmental impacts being traded, and therefore should not be used to measure EUE. It could be argued that the problem is not monetary values, but that market prices do not include the external costs (are private but not social prices). This could be true in the case of socio-environmental impacts. Nevertheless, even if there were no externalities (socio-environmental impacts), the private price would not represent how much nature is being transferred. For example a country could export few kilos of a precious and unique metal with a ridiculously high price generating a great income (monetary value), and at the same time export million tons of an absurdly cheap mineral, producing a very low income. Price is constructed on scarcity: if a good is scarce it is expensive, if it is plenty it is cheap. Thus, utilizing monetary terms is not a good approach of the biophysical exchange. Hornborg (2014) argues that what is really important for the economy are the energy and matter dimensions, because at the end the monetary values are only used to buy the energetic or matter values.

Based on both discussions I can justify the use of biophysical quantity and not monetary values to analyse EUE, which is precisely how I will approach it in this thesis. This conception is shared by all EUE authors I read. In the literature it is possible to find a high variety of ways to measure EUE, several approaches to *biophysical values* can be, as for example: *embodied land, physical weight of raw materials, carbon emissions, embodied water, pollution, waste, genetic material*, and *energy*, etc., while social values are measured by *labour time* (labour theory).

Now, having the unit of measurement, the problem is how to test empirically the theory. Since the late 1990s several authors have been improving methods to test EUE. Technological innovations and data availability have encouraged different methods and several empirical studies. Some examples are: Giljum (2004) who makes a material flow analysis, and recommends doing LCA for all products traded to have a real idea of the material flow between countries. Robert and Parks

(2009) also used a Material Flow Analysis. Moran (2013) used a Leontieff Matrix extended to environmental variables (EEMRIO) to test the trade relations of 187 countries; Dorninger and Hornborg (2015) replicated the same model, but had different results (I will come back to this aspect). Jorgenson (2009) used panel data shows that ecological unequal exchange (1975 – 2000) is progressively over time becoming more unequal. Lawrence (2009) divides the world in a core, semi-periphery and periphery, based on their energy use (strongly correlated with wealth); and also using panel data he shows how countries have changed category (1975 – 2005). Muradian and Martinez-Alier (2001) analyse pollution from mining in the south-north relation. And Jorgenson (2011) shows the importance of Ecological Unequal Exchange in analysing CO_2 emissions in the world, in the increasing context of global warming.

Dorninger and Hornborg (2015) have some very relevant points regarding testing EUE empirically. Empirical EUE studies require complex mathematical models, because all trade relations should be included. Also, as the detailed information which would be needed is not available, researchers make strong theoretical and methodological assumptions. Thus, empirical studies can be imprecise and not reflect reality (Dorninger and Hornborg, 2015). This is precisely what led to the discussion between Dorninger and Hornborg (2015) and Moran et al., (2013), regarding if EUE occurs. Moran et al., concluded that high income countries (the *centre*) would be material net-exporters but not net-importers as the EUE theory suggests. Dorninger and Hornborg (2015) criticized this, and remade Moran's et al., study with the same methodology (EEMRIO) but using an updated database. Their results and conclusion were opposite: rich countries would be net-importers (as EUE suggests). But as they explains, the central point of the discussion is not about which empirical *is right*, but is about the mere fact of testing empirically EUE and interpreting those results. Several authors are using complex models and diverse statistical information trying to prove the occurrence of EUE. Nevertheless, as Dorninger and Horborg (2015) argues, the interpretations on the results should be more cautious because the empirical methodologies are not flawless, rather are based on strong assumptions (e.g. estimating material flow based on monetary flows). The models used aggregates all products and sectors, loosing particularities of each country. And, as Hornborg points, the tangible environmental injustices cannot just be reduced to quantitative technicalities.

The measurement unit and empirical models found in literature are essential to build my framework. Nevertheless, there is an indispensable point I need to clarify regarding the Marxist framework. The social dynamics Bunker suggests as key in EUE (as how local societies are affected by trade), which I consider part of the Marxist framework, are not possible to be analysed from the ecological-biophysical measurement. The ecological perspectives focus on biophysical transfers, and therefore, in my perspective, they lose the social aspects. Therefore, for this thesis I will combine the biophysical flow with a Marxist approach to try to grasp the interaction between *the social* and *the environmental*.

2.2. The Evolution of the theories behind EUE

In this section I will analyse where EUE comes from, which will help clarifying and understanding it better. Figure 1 resumes EUE's intellectual evolution. The theories behind it have evolved hand by hand with the capitalist system (Figure 1 is divided in different historical periods) and each school reflects the problems of its period. Thus, EUE would represent the problems of the present: socio-environmental conflicts. There are two aspects important to highlight: (1) EUE is a critique to

liberal trade approach (competitive advantages theory), and (2) due to its evolution, EUE is closely related with concepts such as *development, centre-periphery* and *dependency*; thus, to the so called Development Theories. Thus, to build the theoretical evolution I will focus on these two points.

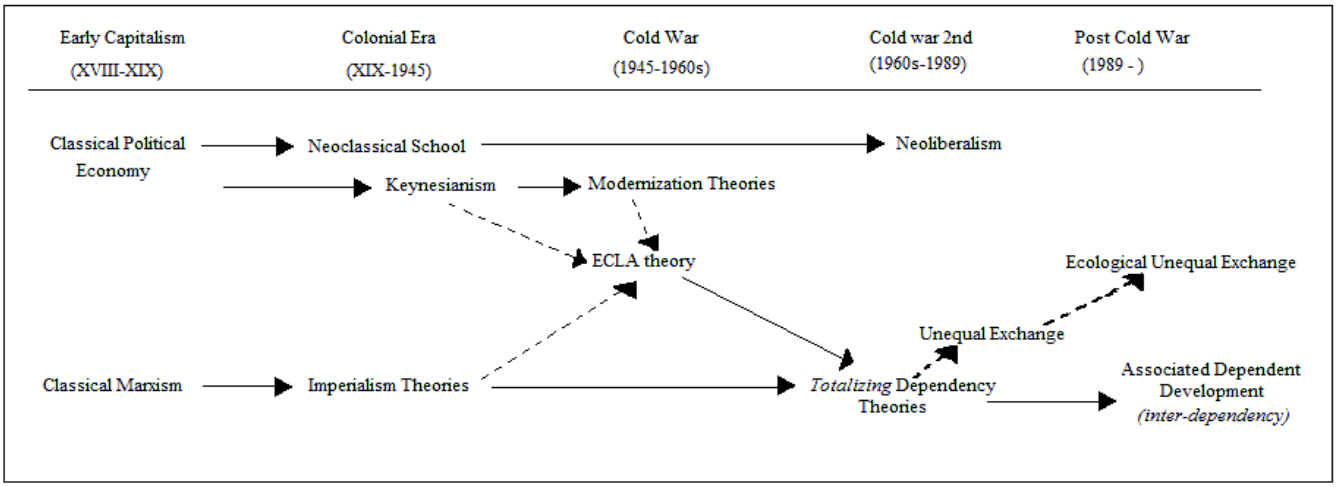

Figure 1: Theoretical intellectual evolution of development and trade theories. *Source: Own Creation, inspired by Larrain's (1989, page 4) historical map of development theories.*

2.2.1. Classical Liberal Tradition

As mentioned, EUE is a critique to mainstream economic trade vision (neoclassical and neoliberal), which is inherited from the **Classical Political Economy** current. David Ricardo (1817, chapter 7) applied Adam's Smith's[1] concept of *labour division* (Smith, 1776, chapter 2) to international trade, originating the *Comparative Advantages* theory. This theory suggests that each country should specialize and trade the good it can produce comparatively cheaper. Following this trading rule would lead to a better economic situation for all the parts involved, and contribute to economic development (economic growth). According to the comparative advantages some countries would be *raw material exporters* while others *manufactured goods exporters*, which is quite accurate to reality. Comparative advantages was modernized into the Heckscher-Ohlin model, but maintained its essence: universal positive effects of trade. Thus, the stronger free markets are (free trade or *laissez-faire*), the stronger and faster development will come. As all trading parts would be benefited from trade, unequal exchange (or EUE) would simply not exist[2]. Under these ideas free-trade has become a main economic policy in the world, promoted through the World Bank and the IMF (sometimes also forced), and defended by the neoclassical (neoliberal) schools.

I have four critiques against this mainstream vision: (1) it fails in describing the consequences trade has (socio-environmental impacts). Thus, it does not consider trade could benefit some in detriment of others, and not be universally good (Unequal Exchange). (2) Mainstream schools dismisses any political issue in their analysis, but considers the economy to be formed by ahistorical and apolitical individuals interacting in a market and free from power relations; conception that simply is unreal.

[1] Smith's work "An Inquiry into the Nature and Causes of the Wealth of Nations" is a meticulous analysis of how the new economic system (capitalism) operated, and how to increase its economic progress.
[2] Prices would represents the real cost (Larrain, 1989), thus unequal exchange could only exist in monopolies or other strong market powers. From a Marxist perspective this is a confusion of the *Exchange Value* and the *Use Value*.

(3) Mainstream considers social and environmental problems only as "externalities" or "market failures", but not as something structural in the operation of the system. Although Marx (2010) explained the motor of capitalism is to take advantages of others. And (4) the mainstream trade approach promises development and that poor countries will catch up with rich countries through trade. But as I will show, inequalities are increasing (analogous to Prebisch's (1949) critique). Due to these issues EUE is at fundamental odds with liberal economics (Rice, 2006). However, I consider Comparative Advantages theory successful in explaining *why countries will produce what they produce*, which is a decision the capitalists make thinking on profits (competitive advantage). Thus, it is good to explain *how trade will be organized*, but it fails in understanding its consequences, which is where EUE can contribute.

2.2.2. Marxist tradition

Ecological Unequal Exchange has its roots in the **Marxist tradition** especially in the so called economic *Development Theories*. The objective of those theories was to analyse why countries have uneven development, how their inequalities evolve over time, and what role *trade* had in it. As *development* concept will be repeated several times in this thesis, it is necessary to clarify or define it: *development* will hold to the classical economic definition, just as synonym of economic growth or capital accumulation, idea shared by the early liberals and Marxists[3] (Larrain, 1989). Due to its evolution, I also consider EUE is part of the uneven development analysis.

Basic EUE concepts can be traced to Marx (1867) who saw that global trade relations generated an international labour division, with some countries selling raw materials and other industrial goods, and opened the opportunity to international exploitation relations (what we call unequal exchange). An essential vision some EUE authors took from Marxism is to consider the socio-environmental conflicts as something structural in the capitalist system, opposite to the neoclassical approach of something "external". Following Marx, the so called **Imperialism theories** emerged in early XX century to analyse Europe's colonization of the world (see Figure 1). Some important authors are Hobson (1902), Hilferding (1910), Rosa Luxemburg (1913), Bukharin (1915), and Lenin (1916)[4], details are found in Larrain (1989). From these theories, EUE took the vision of a world divided into a *"centre"* taking advantage of a *"periphery"*[5]. Despite EUE's intellectual roots in Marxism, at the present not EUE authors subscribe to it, rather EUE is part of a heterodox tradition.

2.2.3. ELCA, Dependency and Unequal Exchange

After WW2 and the decolonization process scholars focused on *what was happening in the peripheries under their relation with the centres*. The **U.N**. **Economic Commission for Latin America (ECLA)** was founded in 1948 under the guidance of Raúl Prebisch with the objective of analysing the development problems in Latin America, and became extremely influential in the

[3] The Marxist idea of development is part of its historical materialism, or Marx's general theory of history, which describes evolution (development) as the transit through different modes of production.
[4] Imperialist theory had several critiques (details are found in Larrain, 1989). Some important were Brown (1972), Cardoso and Falleto (1969), Hinkelammerl (1972) and Warren (1980).
[5] Classical economy authors of the XIX century had already polarized the world into two blocks (Larrain, 1989 page 22): Non-western countries were referred as "non-developed", "backward", "immature", "stagnated", "inferior civilizations", "savage", "incapable of rational reflection" or "with preference for leisure"; while the western world was referred as the "developed", or "the superior civilization of the enlightened nations".

economic policies of the region[6]. Prebisch (1949) posed the question of *why are peripheral countries not catching up with central countries despite increasing its trade (the mainstream promise of development)?* He showed empirically that the *terms of trade* between 1876-1951were constantly deteriorating for Latin America. I.e. progressively the periphery had to sell more raw materials to buy the same amount of manufactures, increasing progressively inequality. Through trade the periphery was transferring its economic activity to the centre which was growing faster and thus widening the gap between them. His conclusion went opposite to the mainstream promise of development, stating that through trade the periphery was in fact underdeveloping. ECLA is a very important root for Unequal Exchange (Larrain, 1989; Roberts and Parks, 2009). Prebisch set the very basis of *Unequal Exchange*, and Some EUE authors have even incorporated the idea of *deteriorating environmental terms of trade* (Rice, 2006; Martinez-Alier, 2002).

During the 1960s a much more revolutionary vision emerged focusing on what scholars considered the *dependent situation of Latin America*: **Dependency Theories** (see Figure 1). Authors were principally from Latin America, and many were part of ECLA, but there are very important authors from different parts of the world. Dependency combined sociology, political science, and history (*historical materialism*) with economic aspects. However, dependency thoughts were not one unified theory, but had a high diversity (in fact not all authors were Marxists). We can distinguish two main currents (Larrain, 1989). The first one can be referred as ***totalizing dependency*** (see Figure 1: Theoretical intellectual evolution of development and trade theories. Source: Own Creation, inspired by Larrain's (1989, page 4) historical map of development theories.; some important authors were Theotonio Dos Santos (1970, 1978), Orlando Caputo and Roberto Pizarro (1970), Ruy Mauro Marini (1973) Vania Bambirra (1972), Adre Gunder Frank (1967 and 1973), Arghiri Emmanuel (1969), Samir Amin (1970) and Immanuel Wallerstein (1974). Totalizing dependency considered the world as a unified capitalist system connected through unequal exchange. The centre would continuously develop because it exploits the periphery through unequal exchange, while the periphery would continuously undevelop. *Centres* would be rich thanks to the *peripheries,* which would be poor by *centres'* faults. It is a strict dichotomised vision of the world, which as presented in point 2.1, is shared by several EUE authors.

There are two important mechanisms to maintain the *centre-periphery* status quo: (i) the periphery would depend on the centre's technology, losing the spill-over effect of producing capital goods (main driver of development). And (ii) the high price of technology would generate debts, pushing countries to exchange their resources (their economy available) in pursuit of foreign currency to pay them (Dos Santos, 2015). Both would hinder the periphery's opportunities to develop. Hornborg (2014) explores the role of technology in EUE, as being a mechanism how EUE happens. However, I did not find EUE authors discussing the role of debts in the unequal trade relation, as a mechanism of control, forcing trade and maintaining the status quo.

[6] Based on ECLA's thought, between the 1940s and 1960s Latin America implemented policies to improve their unequal exchange and therefore increase their development. International trade was controlled increasing tariffs, and an industrialization process started to avoid buying centre's manufactures. Despite this plan didn't succeed, I consider it important for EUE's evolution because it shows the big impact an unequal exchange theory can have in the policies of a country, even promoting a whole reorganization of their economic systems.

From totalizing dependency theories **Unequal Exchange Theory** arose taking the trade issue to a superior theoretical level. It explained in detail the mechanism how a country took advantage over other[7]. Its principal authors were Emmanuel (1969) and Amin (1970)[8], and their objective was also to explain uneven development through trade relations. They followed the Marxist tradition, and considered that *Unequal Exchange* was the despair transfers of surplus value (labour embodied in products) between countries. I.e. exploitation between countries based on an international labour division. They adhered to ECLA's idea of deteriorating terms of trade to explain growing inequality. Emmanuel considered that developed countries would benefit from unequal exchange as a whole (not only their elite but also their working class). Unequal Exchange is the theory leading directly to EUE, which upgraded it with the ecological aspects. This may be the reason behind why several EUE authors have the idea of a strict-totalizing-dependency (centre exploiting a periphery in exclusive benefit of the first), yet, there are also authors without this strict vision.

Amin (1970) differed with Emmanuel's totalizing vision. According to him centre's working class would not benefit from unequal exchange, so they would not be part of the exploitation of periphery's labour. But centre's labour would have higher wages and higher material standards due to their successful class struggle (Larrain, 1989). Amin points one way of accumulation was taking advantage of periphery's low salaries and transform them into manufactured goods exporters (Amin, 1976). Finally, despite the surplus transfer would be significant for the periphery, it would be marginal for the centre. I.e. the centre would be its own centre, and do not need the periphery to explain its development experience. For the construction of my framework there are some very important elements from Amin to be taken, specifically the *class analysis*. I.e. the periphery would be exploited by the capitalist class of the centre. And that *the centre is its own centre*, suggests that rich countries' development cannot only be explained by its exploitation of poor countries, but their own historical experiences must be considered. Other important point is that Amin considers the periphery could industrialize from unequal exchange and become a manufacturer producer. I.e. the periphery could develop. Thus, there would be more flexibility in the totalizing vision.

Related to this idea of flexibility, Wallerstein (1974) included in the world-system analysis a third cathegory: semi-periphery. This cathegory represent those countries industralizing and diversified exports, and would be a consequence of the international labour division. Arrighi (1990) explains they benefit from the relation with the periphery, but are affected by the relation with the centre. This approach includes the idea that countries can upgrade or degrade in the world system. However, Arrighi (1990) analysed empirically country's mobility inside it, but were not so

[7] The assumptions for his model are that capital flows while labour is fixed in the countries (people cannot migrate, but capital does). Therefore, profit rates are internationally equilibrated, while salaries are different (depending on national socio-historical conditions). According to Emmanuel, there are two sources of unequal exchange (or international exploitation): the salary gap between periphery and centre (principal reason) and the different organic composition of capital among countries. There would be a progressive deterioration in the terms of trade. Peripheral countries would have to progressively exchange larger amounts of labour (embodied in production) in change of the same amount of labour from central countries. Thus, following a Marxist analysis, unequal exchange would be produced in the factor market (regarding the price of wages and capital), and not in the commodity market. And to Emmanuel, the difference between centre and periphery is not regarding what king of good they produce (which was ECLA's idea), but regarding their salaries and rate of profit.

[8] Amin's contribution to unequal exchange is to include the idea of *productivity difference* to the model as the causing force unequal exchange.

optimistic about it. He showed South Korea and Taiwan had become semi-periphery (until 1983), but he considered them as exceptions, because *advancements in the periphery would only be "illusions"*. One idea supporting this, as Robert and Parks (2009) explains, is that moving up in the hierarchy can face the powerful opposition of central countries defending their position through political, economical and militar power. In my opinion the semi-periphery is important for EUE because it suggests the relation is not a unidirectional flow of benefits and costs (totalizing vision), but some countries can develop. Thus, into some extent , benefist would be distributed in the world-system. An example of this are South Korea and China. From being periphery, the first is now a central-technology leading country, while China has become the factory of the world (semi-periphery) and will in few decades be the biggest economy of the planet *(centre?)*.

There are several authors **criticizing the totalizing dependency theory**, details can be found in Larrain (1989)[9]. Liberal economist criticise that unequal exchange or dependency simply does not exists, because trade is done at equilibrium prices. Thus, no underpayment would exist and the inequalities between countries would be by productivity differences. Lall (1975) has a very relevant point stating developed countries also dependent on foreign capital and trade, that they also have marginality and poverty, and that there are also peripheral countries exporting industrial goods. So the diversity is broader than just dividing in centre and periphery. Bettelheim (1972) criticises there are cases of low wages countries with high organic compositions selling in the international markets, and thus centre's companies cannot compete (unfair trade). Warren argues that to produce underdevelopment the drain of surplus should be total, which is not the case, because despite the centre main gain more from the trade relation, the periphery is as well gaining something; both sides wins, but in different intensities (it is not a zero sum game). Two very important discussion were Laclau's (1977) and Brenner's (1977) critiques to Frank and Wallerstein respectively. Both criticise the reductionism in Frank's and Wallerstein's theory. They consider a big mistake to assume that all relations of production are capitalist relations. The periphery has a big diversity that cannot be generalized (many non-capitalist relations). There can be several modes of production interacting, thus it would not be enough to state there is exploitation in the relation (underpayment), but the particularities, internal dynamics, and historical processes must be considered. Brenner explains that focusing and trade, markets and profits, loss the focus of how production is really organized through the labour relations. The State would also be adapting to secure the trade system. They also criticise that explaining development differences thought international exploitation between countries misses the fact that exploitation is a relation between classes, and not countries.

Arrighi (1990) had some very relevant criticism pointing that *industrialization is not the same that development*, and that *core is not the same that industrial*. He explains the centre is deindustrializing, while the semi-periphery is industrializing (South Korea and Taiwan), without changing the world-system hierarchy. And as differences would grow between countries, it becomes more difficult to catch up. I.e. Arrighi (1990) considers *development is an illusion*, and that not all countries can be developed. From Arrighi I infer that a fundamental difference between centre-periphery is how wealth is distributed: *"The fact that semiperipheral states as a group can never attain the national standards of wealth set by the core states does not mean that particular*

[9] For example, Laclau, Brenner, Warren, Bernstein, Phillips, Taulor, Mande, Booth, Banaji, Kitching, and Leys. Details are found in Larrain (1989).

classes or groups within the semiperiphery cannot enjoy standards of wealth analogous to those of their counterparts in the core. […] The other side of the coin has been a mass poverty for the lower classes of the semiperiphery that resembles or even exceeds that of their counterparts in the periphery." (Arrighi, 1990. P. 27). Thus, development would be related to class structures, or how wealth is distributed permitting inhabitants to access higher material-live standards. Semi-periphery has concentrated the industries but without becoming *developed,* because the wealth is still not distributed, as for example China and India today. Thus, a class analysis is needed. Furthermore, the inclusion of a semi-peripheral element in the theory is relevant for my framework because Chile can be considered in this category. And having a semi-periphery in between the centre and the periphery generates theoretical complications in the strict-dependency framework, regarding how to understand its role and how it is benefited and/or affected by its international relations. This is precisely what I will explore from a EUE scope for Chile.

Arrighi also points that unequal exchange would not be enough to explain differences between countries. There would be more mechanisms dividing centre and periphery and perpetuating the world-system, as e.g. *unilateral -forced transfers of capital and labour*: a centre invading a periphery to take their oil supplies. Based on Arrighi unequal exchange may not coincide with core-periphery. I will discuss this in the next section, and is related to *how unequal exchange occurs*.

2.2.4. Relative Dependency and interdependency

Despite these criticisms, Larrain (1989) has a very important point regarding they failed in considering Dependency Theories are not unified but very diverse. These criticisms fit in the totalizing-dependency view. But in parallel to this view, a flexible and relative school of dependency was developed: the ***Theory of Associated Dependent Development*** by Cardoso and Falleto (1969) (see Figure 1). According to Larrain (1989), Dos Santos (2015) and Caputo (2015) this is the precisely the vision that prevailed until the present, and that is still considered valid to explain countries' connected in the global economy and its effects on uneven development. Associated Dependent Development had a different focus from the totalizing dependency current, and in fact had incorporated several of its critiques. Cardoso and Falleto considered development in the periphery (under dependency relations) as possible and a reality. This is opposite to the totalizing current that considered centres would exclusively develop while the peripheries would underdevelop or be stagnated. Rather, *development in dependency* would occur when the interests of the *centre's* elites would be compatible (aligned) with the interest of *peripheral* elites, generating an *Associated-Dependent-Development*. The key would be to negotiate a less unequal exchange.

Further, this theory also considers that economic dependency (Unequal Exchange) is not enough to explain inequalities between countries. Rather, particular, social, political and power relations of each country need to be considered (as national conflicts, internal relations of production and their historical transformations, i.e. the internal class struggle). Its states the problems of the periphery cannot be considered as a whole without specifying their diversity and the particularities of each country. There would be many different expressions of *dependency*, and therefore a global (totalizing) theory would not make sense. *Dependency* would express itself when the external interests organize and transforms local socio-economic relations. Therefore, the unequal exchange would not have the same effects in the whole periphery. This is related to Arrighi's (1990) discussion, that despite semi-periphery was industrializing they were not developing; or while

despite the centre was deindustrializing, it was not undeveloping. Furthermore, Arrighi explains that despite centre-periphery hierarchies are not changed, industrialization have transformed the semi-periphery, as e.g. peasants have become minority through a proletarianization process in many countries, creating workers movements and unbalancing the local power hierarchy. This is precisely an example of what Cardoso and Falleto pointed as important particularities of the unequal exchange relation, and how it can transform local realities.

Finally, for Cardoso and Falleto, dependency is not a theory, but a concept inside a Marxist framework (I consider Hornborg is close to this idea also). Dependency (unequal exchange) would be the dynamic process whereby *peripheral* structures (social and economic systems) would process the impacts of *centre's* capitalism. And to understand economic development it is necessary to analyse how these national structures have changed over time under unequal exchange. More than dependency, Cardoso and Falleto considered the relation between centre and periphery to be of ***interdependency***, but being different qualitatively and quantitatively in each direction, because the power relation is not even. Countries' social groups would be interconnected in a complex net, thus strict unequal exchange would not be an appropriate approach to understand their relation.

After presenting what is Ecological Unequal Exchange and where it evolves from (sections 2.1. What is Ecological Unequal Exchange? and 2.2. The Evolution of the theories behind EUE), I will proceed to present the conceptual framework I will use to analyse my empirical study.

2.3. Conceptual Framework

Based on the literature review I will now present the conceptual framework I will use for my empirical analysis. I will start recapitulating the main points of Ecological Unequal Exchange. After the Cold-War critical ideas to capitalism were progressively dismissed, while neoliberal thought became hegemonic. This can be seen in the fast economic opening of the countries through the promotion of free trade agreements over the world, led by the World Bank and the IMF and inspired by the free market and competitive advantages theory. These theories suggest trade has positive effects for all trade partners and thus would promote development. In this context Ecological Unequal Exchange (EUE) emerges as a theory challenging the neoliberal hegemony, questioning the presumed universal benefits of international trade and its link with development. From my perspective, the competitive advantages theory is good in explaining how a capitalist will take decisions, and thus explaining what a country will produce and export (and also why it will produce it). Nevertheless, the theory fails in understanding the diversity of consequences trade has, as e.g. considering the negative socio-environmental impacts. And this is precisely the aspect where EUE can contribute to understand how the world is interconnected, and therefore also represents a critique to mainstream trade theories. Furthermore, as shown in the literature review, EUE is part of the so called Development Theories, thus its objective can be considered to be explaining inequalities in the development experiences between countries[10].

As presented in the literature review there are several points shared transversally by EUE authors. EUE is considered to be an asymmetric transfer of biophysical values between countries, an underpaid exchange, in the context of a world divided in a centre and a periphery connected through

[10] Development was defined in the literature review as a material condition, capital accumulation or economic growth (all synonymous).

unequal exchange relations with uneven economic and politic power. This vision is inherited from ECLA and dependency theories of the XX century, but its fundaments can be easily traced to Karl Marx, which laid the foundations of this analysis. The new and essential element that EUE added is the environmental critique, which transforms completely the way of understanding how distant societies and their surrounding nature are interconnected by complex economic relations in a world system. Nevertheless, although these elements are shared in EUE theory, different authors have different ways to approach the problem. Thus EUE is not a unified theory. Rather, just as dependency theories (classical unequal exchange), there are different currents inside. Several authors have different conceptions of EUE, which has led in fact to approaches that differ substantially even to the point that seems to be different theories.

One of these approaches is what I called in the literature review as totalizing Ecological Unequal Exchange, considering that development of the centre and periphery would be a dichotomist or antagonist relation. The centre (productive economies) in its accumulative process would appropriate biophysical values from the periphery (extractive economies) which would flow from the periphery to the centre to sustain the latest's disproportionate economic activity. Thus international inequality would be generated and centres would be disconnected from the socio-environmental impacts of its consumption and development. Only the centre would benefit and develop of the trade relation, while the periphery would absorb its negative effects and be worsened (antagonist relation). In this vision countries would benefit or be worsened as a whole of trade, despite their inner class differences. This vision is present in EUE authors as Muradian et al. (2002), Andersson and Lingroth (2001), Rice (2006, 2007) or Roberts and Parks (2009). And as shown in the literature review this vision evolves from the totalizing dependent theories as Dos Santos, Caputo, Frank, Wallerstein, and Emmanuel, from which it inherited its worldview. Wallerstein's semi-peripheral category is added by some authors, as a group that can benefit and worsen, but it does not alter the relation between centre and periphery, where the first would benefit of the detriment of the second.

Furthermore, other characteristic of this group (the totalizing EUE current) is that most authors consider EUE as a strong theory, and focus on testing empirically the asymmetric transfers of different kind of ecological values (CO2, footprint, land, water, etc.), i.e. a physical quantifiable approach. But by doing this, I consider they loses the focus from the social problems related to trade, as the socio-economic relations, and thereby from impact trade has on the development of a country, which I consider should be a main objective to understand of Ecological Unequal Exchange theory.

Following I will present my EUE framework, which is not based on this totalizing approach of EUE, but rather in a "more relativist" approach. To build this framework, the criticisms presented in the literature review to strict unequal exchange were very relevant, because many can also be applied to the strict EUE view, which as I explained evolves precisely from the totalizing dependency current. As I expect to show, if we relax these strict views and include some of the mentioned criticisms the accuracy of EUE to explain the complex relation between nature-society-economic trade and development can be substantially increased. I will precede listing several points that comprise this framework, and which are closely interrelated:

1. From Cardoso's and Falleto's (1969) theory of Associated Dependent Development I will take that development under unequal exchange relations is possible and is a fact. In opposition to the totalizing views that considers only the centres would develop and benefit from the trade relation, Cardoso's and Falleto's view considers that the periphery can also be benefited from it (associated dependent development). Warren had the same critique against the totalizing views, arguing that to produce underdevelopment the drain of the benefits would be complete, which was not the case, because a part was also staying in the periphery (unequal exchange is not a zero sum game). Related to this, Amin (1970) pointed that the centre's development could not be explained by its exploitation of the periphery (as totalizing views suggests), rather, the centre would be its own centre. Nevertheless, I consider that periphery's underdevelopment is strongly related to its relation with the centre, regardless the implication may not work in the opposite way as Amin argues.

Therefore, and following the authors, I will dismiss the idea of dependency, but replace it by the idea of interdependency. These aspects are very relevant, because Chile has indeed economically developed since the 1960s, and therefore the idea of a totalizing-unequal exchange would not fit in the reality of the country, despite it could fit for other countries realities.

2. The totalizing approach in its strict view misses to consider diversity. In reality there is diversity in the roles of the world system, i.e. there is diversity in the centre-periphery relation. Emmanuel (1969), Amin (1970) and Bettelheim (1972) argue there are also rich countries exporting raw materials and poor countries exporting manufactured goods. Examples could be Norway exporting fossil fuels, or China and India exporting manufactured goods. Related to this Arghirri (1990) argues the centre is deindustrializing while some peripheral countries are industrializing, nevertheless, apparently without affecting the world hierarchy. Lall (1979) points that developed countries can also be dependent on foreign capital and trade, and that in their national reality there is also marginality and poverty. Therefore, the world-system would be much more diverse than what the strict-totalizing approaches portraits it: a centre-rich-industrial and a periphery-poor-extractive. These criticisms to the strict homogeneity also reflect that roles are changing over time and that there is mobility in them (Wallerstein, 1974; Amin, 1970; Lall, 1975; and Arrighi, 1990), i.e. peripheral countries can become a manufacturer producer leaving their extractive economy behind. This is related to the first point, i.e. that the periphery can develop. Examples are South Korea which from being periphery became a world leader technological centre, or Taiwan that has become a manufacturer producer. As shown in the literature review Hornborg is an author of EUE that incorporates these diversity ideas, and therefore this framework is closer to his approach to EUE. Furthermore, Arrighi (1990) discuss that unequal exchange is not enough to explain the differences between countries, but would be one of the several possible reasons; and that in fact unequal exchange relations may not coincide with core-periphery hierarchy. Both aspects are important to take into account when analysing Chile's case, and therefore it is needed to be cautious with the conclusions regarding EUE.

Wallerstein's concept of semi-periphery is essential to be incorporated to the EUE framework. The semi-periphery represents a theoretical challenge for the totalizing visions. It suggests that the relation of the centre and the periphery is not a unidirectional flow of benefits and costs (as the totalizing vision states), but there are countries in between, and that benefits would be being distributed in the world-system. Chile is precisely a semi-peripheral country, it is not rich and

developed as western European countries, and neither is poor and undeveloped as some African nations, therefore Chile stands as a semi-periphery in the middle of the world-system hierarchy.

3. According to several authors there is also diversity inside the countries, and in the way benefits and costs are distributed nationally. Amin (1970) considers that not all classes inside the country would be benefiting of exchange (opposite to Emmanuel). Rather, some classes would be benefiting more than others, as well as some would be more affected. The same class idea can be inferred from Hornborg (2014), i.e. unequal exchange can also take place between social groups. This is closely related to Cardoso's and Falleto's (1969) idea considering that the peripheral elites were managing EUE through aligning their interests with the centre's elites. Brenner (1977) had a related point discussing that the State would also be transformed to secure the functioning of the unequal exchange, thus acting as a class-mechanism. These points are very important considering that Chile is a country with extreme wealth inequality and with a State that was violently transformed into a neoliberal-institution. Thus, these factors are essential to be considered in the framework.

4. As the benefits and costs of EUE are not distributed equally, it is important to analyse the particularities of inside the countries. From Hornborg (2001), in considering EUE is in essence interdisciplinary, I infer that for EUE it is not only important to analyse the physical trade (quantities) as the strict views focus, but also the "non-physical" aspects involved in trade, i.e. the social dimension included in trade as e.g. the social impacts. Brenner (1977) and Laclau (1977) criticized totalizing unequal exchange highlighting that inside countries not all realities are capitalistic, but there are different economic systems interacting. From Laclau and Brenner an interesting question that emerges is if EUE affects in the same way non-capitalist and capitalists modes of production. Is there any difference? E.g. is an indigenous community affected by trade in the same way and industrial proletariat? I consider this is the very key to analyse how EUE occurs (one of my research questions and objective). Analysing particularities is essential to understand how trade affects the countries. I.e. how the social relations of production and the local dynamics are affected by trade, and how trade can reorganizes the local realities. In my opinion this is precisely Bunker's (1984) approach to EUE, when analysing the impacts trade and resource extraction in the Amazonas had on the environment and society of the periphery.

Cardoso and Falleto considered that economic dependency (Unequal Exchange) was not enough to explain the inequalities between countries, rather particular social, political and power relations of each country needed to be taken into account (as national conflicts, internal relations of production and their historical transformations, i.e. the internal class struggle). Therefore, I consider that understanding how local societies react and are transformed by the global economic activity will help us understanding the consequences trade has on the development of those societies and therefore understanding international inequalities. I.e. analysing these particularities –how EUE occur- would be the direct link between EUE and development (second research question).

These aspects are closely related to the class issue discussed in the previous point, because the class benefiting from EUE would be the agent managing it and promoting the changes at the local level. This is also related to the idea Cardoso and Falleto (1969) had when considering that dependency would express itself when the external interests associated with internal elite's interests would organize and transforms local socio-economic relations. As the authors state, these dynamics are

different from country to country, i.e. social dimensions are particular for each country. Thus EUE and interdependency is not one, but has several expressions, taking distance from strict-EUE visions. The way EUE occurs in Chile may not be the same it happens in an African or Asian country. As well as it can also differ for different regions inside Chile.

5. And finally, analysing particularities of each country is part of a Marxist approach to EUE, and is not possible to be done from the strict quantitative approach some EUE authors have. In my perspective, the strict approach by focusing exclusively on measuring biophysical transfers loses the particularities of the social dimensions that I consider key for EUE and its consequences; and thus, without them EUE theory falls short in explaining international inequalities and uneven development. Furthermore, Hornborg argues there are several social aspects that cannot be measured and that the tangible environmental injustices cannot just be reduced to quantitative technicalities. Dorninger and Horborg (2015) explain empirical methodologies are not flawless, and therefore the interpretations and conclusions based on quantitative studies should be very cautious. Based on these criticism to strict-EUE (empirical testing), but understanding that having a notion of the biophysical flow is essential, for this thesis I will combine the biophysical flow with the Marxist social approach to try to get a better insight of the interaction between the social and the environmental.

Using this framework, that mixes relative EUE with the several criticisms against strict unequal exchange, I expect to have a more accurate approach to explain Chile's trade relations as its consequences for the country. I think it is important to highlight that this EUE approach achieves mixing the traditional social problems as poverty, inequality and uneven development, with the "XXI century's problems" as global warming, climate change, pollution, environmental degradation, or resource depletion; and explains how they are interconnected in the globalized world, and how they affect local realities and the development process of different countries. However, it is important to remember that EUE would be one concept explaining socio-environmental injustice and inequalities in the world, but not the only one (Arrighi, 1990). Nevertheless, considering that my EUE framework includes a society formed by cultural and political persons, with history and power hierarchies interacting in a complex web of environmental relations, rather than a society composed by individuals living in a market (as assumed by mainstream economics), this EUE approach can help explaining several issues neglected and bypassed by the mainstream competitive advantage economic theory.

Furthermore, I will treat EUE as a concept inside a Marxist framework to analyse the complex relation between nature and society, based principally on a qualitative approach (social dimension) but mixing also quantitative information (biophysical dimension); rather than a rigid empirically testable theory. I consider both the social and the biophysical dimensions are essential and need to be analysed together, because the environmental crisis should not be separated from the social crisis. I consider that integrating both dimensions is precisely how EUE can contribute to understand the consequences of global trade. And understanding the relation between society and nature can help negotiating better terms of ecological unequal exchange (as Cardoso and Falleto suggests), and therefore helping achieving a sustainable development.

3. Methodology

3.1. Used methodology

To analyse Chile's EUE this thesis uses quantitative and qualitative methods. First I conducted a quantitative empirical investigation focusing on statistics regarding physical trade, as volume and tonnes, i.e. a Material Flow Analysis. As explained in the literature review, these physical measurements are used as proxy to analyse the *biophysical values* or nature being traded between countries. Secondly, I did a qualitative analysis on the socio-ecological impacts embodied in the products traded. Covering both dimensions (quantitative and qualitative) I expect to have a more accurate approach to Chile's EUE.

The objectives and research questions were defined together with my supervisor. These questions were discussed in several meetings, and evolved as the investigation progressed and different limitations and new ideas appeared. The limitations were mainly related with the need of reducing the study's coverage and focusing on more specific issues, due to data and time constraints.

The literature review was done based on several academic articles and books provided by my supervisor; mixed with material I researched by myself.

The statistical information was compiled principally from the following sources:

1. United Nations COMTRADE-Database (UN-Comtrade): is a repository of official trade statistics between countries from 1962 to 2015 (monthly updated). Variables are found in monetary and volume terms.
2. U.N. Economic Commission for Latin America and the Caribbean BADECEL-Database (ECLA-Badecel): is a statistic international trade database focused on Latin American countries, with information from 1970 to 2011. Variables are found in monetary and volume terms.
3. Chilean Central Bank: official source of Chilean economic statistics and their evolution over time. Variables are found in monetary terms.
4. "Chilean Economy 1810-1995: historic statistics" publication from Chile's *Pontificia Universidad Catolica* Economic Institute by J. Braun, M. Braun, Briones, Díaz, Lüders and Wagner (2000), containing detailed statistic evolutions for several variables related to Chile's economy.
5. Chilean statistics from official governmental institutes as the Chilean Copper Commission (COCHILCO); the Geology and Mining National Service (SERNAGEOMIN); Chilean Customs (Aduanas); and private institutions as the National Mining Society's (SONAMI) mining newspapers published monthly since 1883.
6. Several solicitudes were directed to Chilean Ministries and Public Institutions through the *Transparency Law* (the right of any person to access public information) to access specific data and information. The solicitudes were the following (code): AW003T0000324, AU002T0000376, N° 29.462, AS004T0000136, AU002T0000242, AS002T0000018, AW004C-0001340, and AU002T0000376; directed to the Environmental Ministry, Energy Ministry, Energy Sub-secretary, Mining Ministry, and the National Institute for Human Rights.

7. International economic, social and environmental Statistics were collected from the World Bank (WB) and the International Monetary Fund (IMF) databases.

The statistics gathered were organized in databases containing several variables as type of trade (imports or exports) in monetary and physical terms, countries trading, products traded, GDP growth, and population among others. Each database contained the evolution of these variables from 1962 to 2014. Trade data is based on the Standard International Trade Classification Revision 1 (SITC-Rev.1) used by the UN to classify in different categories the products traded. As different data sources present their information in different measurements data had to be processed and homogenized to make it comparable. Biophysical variables were converted into the same weight unit. And as trade statistics shows monetary variables in current prices, to analyse its *real* evolution they were converted into constant prices, using as base US$ dollars from 2014. Basic statistical methods were used to process the information; such as arithmetic means, percentages, graphical analysis, and tendency analysis of curves. With these methods I compared the evolution in time of different variables and countries. In the thesis data is presented in forms of tables and graphs.

3.2. Methodological Obstacles

In this section I will discuss relevant methodological problems which emerged during the research.

3.2.1. Limiting the empirical case, and information scarcity

A problem I met several times was how to set limits to the study. A complete EUE analysis would need to cover all the transactions Chile has with all its trade partners and the socio-environmental impacts embodied on it. But this level of information does not exist, and thus is an essential limitation for EUE empirical studies. As explained, I used physical weight as a proxy to biophysical values (which is suggested in the literature). Despite I admit the products' weight is not a perfect proxy to the nature embodied on them, it is the best alternative available. In order to have more accurate information, Giljum (2004) recommends making LCA for all the traded products. This would help in fact solving the information problems, but in reality it is a titanic and probably impossible task.

As the amount of information needed increases with the amounts of analysed countries and products, I decided to focus the empirical analysis in Chile's main four exportation products (Iron, Copper, Salt and Wood), and its main trade partners (China, USA and Japan).

3.2.2. Incomplete Statistical Information

Even despite limiting the empirical study, a problem I faced on several occasions was that the statistical databases were incomplete. Actually, even the official databases of the United Nations, World Bank, ECLA or the Central Bank had information missing. E.g. for the year 1979 there were no statistics available regarding Chile's biophysical exportations in any of the analysed sources, thus it was omitted from the analysis. One reason could be that trade studies are normally done based on monetary values (US$), information which was widely available, but not in biophysical values. Other issue was that in some occasions data differed considerably depending on its source. In those cases the variables were compared with several other sources choosing the most similar ones, and analysing its sense in the historical evolution of the variable, thus avoiding distortions. Also, statistical information on socio-environmental impacts was very scarce. Thus, they were mainly approached from articles and books, based on qualitative information.

3.2.3. Chains of impacts

A relevant issue I met was how to evaluate the chain effect of socio-environmental impacts on trade, which is discussed by Dorninger and Hornborg (2015). E.g. in the case of Chile, the country imports fossil energy from the USA, which are used in a high share by the mining production, which is later exported to several countries (including the USA). As the mining industry has several environmental impacts (as soil and water pollution) it affects local communities. Thus, through this chain effect, some socio-environmental impacts in Chile can be linked directly with USA's trade.

This is a methodological complication in the sense of *how to define to which countries the impact should be attributed* and *in which quantity*. An underlying problem is that the global economy is a circular process which is constantly repeated. Thus, trying to analyse EUE based on a bi-directional exchange between two countries is not enough to grasp the economic dynamism and the broad interconnections. This is also present in the literature review under the idea of "interdependency". As there is no precise quantitative information for the case of Chile to analyse the chain effect, I will discuss it from a qualitatively perspective, and quantify it only when the information allows it.

3.2.4. Measuring Ecological Unequal Exchange

Related to the previous obstacles, a substantive methodological problem I met was regarding the *unit of measurement* of EUE, i.e. *how to measure EUE*. Based on the literature review, I decided to use biophysical weight traded between countries, nevertheless, this assumes that *one ton of X product* is equivalent and comparable with *one ton of any other products*. E.g. it assumes that one ton of an organic-ecological fair-trade crop would be equivalent to one ton of industrial chemical-intensive monoculture crop. For the case of Chile it would be for example that one ton of copper would have the same amount of embodied nature (incorporated ecological processes) than one ton of wood or any other product. This is simply not true, and is a very strong assumption. From my perspective, products are not really comparable through tones. Weight is far from being a good approach to the nature embodied, and therefore to EUE. However, it is the best option available.

Embodied labour-value is also a problematic variable. Labour represents the social dimension of EUE (or the classical unequal exchange). But there is no information about how much embodied-labour a product has (at least for the case of Chile). As Hornborg (2014) suggests, labour may not even be quantifiable, because it has a social and cultural dimension that is not the same in different countries. Therefore, the particular working conditions and exploitation regimes surrounding the productive process must be considered. E.g. one hour of slavery in a dictatorship should not be considered equivalent to one hour of a free-worker in a rich democratic country. For this thesis, it could be applied comparing Chilean with Chinese or USA's work[11].

Very related to the qualitative differences, a deeper question that emerges is into what extent are socio-environmental impacts and diverse ecosystems from different countries are really comparable. Countries have different sizes, different amount of people, and different cultures. Thus, are immense territories as China (the most populated country in the world) or the USA comparable

[11] A similar analysis can be extended to other units of measurement, as for example to *land*. First, there is no such information of how much embodied land each product has. And second, *one hectare of land in a tropical forest* may not be the same that *one hectare of Nordic agriculture land*, or *one hectare of a desert land*. Different ecosystems may not be comparable.

one to one with a small country like Chile?[12] Or can the different ecosystems and cultures (many of them unique) of distant parts of the world really be compared? E.g. the destruction by an industry (mining, forestry, etc.) of *hundred hectares of a forest* used by a urban community in a developed country for recreational purposes, may not be comparable with the destruction from the same kind of industry of *hundred hectares of a forest* used by a indigenous community (since ancient times) in a poor country to make a living and for religious purposes. Although the physical quantitative dimensions of the destruction could be the same *(hundred hectares of forest;* number of species extinct; CO2 equivalent emitted, etc.), there would still be a qualitative or cultural dimension, not quantifiable, making them essentially different. Thus, the comparison of embodied nature and socio-environmental impacts from different places is very complicated, and it is not possible to weigh them in a sort of balance scales. Several particular aspects need to be taken into account, as for example local historical experience and their culture constructions, which is closely related to ideas from Laclau, Brenner, Cardoso and Falleto (in the literature review). And is precisely how Bunker and Hornborg approach to EUE. Thus, I will avoid the quantitative comparison of socio-environmental impacts, but prefer a qualitative discussion.

These issues are directly connected with Dorninger's and Hornborg's (2015) critique to the empirical testing of EUE. As presented in the literature review they argued that due to the lack of information testing EUE is very difficult, and therefore researchers have to make strong assumptions, but taking distance from reality. Therefore, they recommend being very cautious with the conclusions on EUE studies. Recommendation I will take very seriously.

3.2.5. Assigning EUE: class distributions

As discussed in the framework, as benefits and costs can be unevenly distributed inside a country, an essential aspect is how to distribute them to be analysed considering the diversities existing in each country and its particularities. Countries can have several different *realities* inside them, people are not homogenous. In the case of Chile there are different communities, cultural groups and classes. Thus, benefits and costs should not be attributed to the country as a whole. In the case of socio-environmental impacts, they are normally local (related to some sector) affecting only some groups, but not the whole country. An example, as we will see for the case of Chile, mine owners are benefiting enormously from their activity, while communities surrounding the mines are assuming its negative costs, as water pollution and depletion.

Thus, the relevant issue is to determine what particular social classes or social groups from each country are being benefited or impacted, and how they are being affected. In the case of Chile, the groups normally affected are the marginalized parts of society, or poor classes; while the benefited are the high classes (bourgeoisie or oligarchy). To grasp this class dimension, cultural and historical factors and power-relations must be included to build a better model of unequal trade relations, and increase its accuracy to explain reality. Therefore, I will approach this issue through discussing qualitatively some selected case studies, as pollution episodes and communities' struggles against companies, as well as commenting the position the owners (benefited part) has on Chile's society. I consider this perspective very relevant, because it permits having a bottom-up approach to EUE,

[12] A future recommendation would be to adjust all the variables by the amount of people in a country (per-capita) and by the physical dimensions of the country.

uncovering a reality that is hidden by strict-quantitative studies. As discussed in the literature review, this class approach is also the key to understand the link between trade and development.

A situation that can make more problematic the class analysis, is taking into account the State as a redistributive agent. E.g. the State makes redistributive policies, and has public companies. Actually, in the case of Chile the biggest copper company is State owned (CODELCO), entangling how benefits and costs should be assigned in the EUE analysis, because its income is used to finance several public goods.

4. Background: the case of Chile

As the focus of this thesis is to explore Chile's unequal exchange, there is some relevant information that can help the reader to contextualize the country better.

4.1. Chile's historical trade relations

In this brief section I will discuss the possibility of Ecological Unequal Exchange in Chile's history. According to Frank (1967), since the arrival of the Spanish empire Chile and Latin America were turned into mercantile societies to serve the *centre's* interests. First the *centre* was Spain, and then moved the rest of Europe (especially England) and later the USA. Thus, Chile should have been having unequal exchange relations from its colonial period.

Since the colony, Chile's economy has been organized externally (from other countries: the *centres*) impacting as well the country's social organization. In the XVIIth century Chile's principal production was cattle, needed to produce leather bags to carry the minerals in the Peruvian Viceroyalty (e.g. Potosí silver mine); and tallow used for candles needed to light those mines. Chile was an exporter and did not have major imports from other countries. And Chile's basic productive unit was small cattle farms. But in 1687 an earthquake destroyed Peru's irrigation network, leading to the collapse its agricultural sector. Thus, in the XVIIIth century wheat became Chile's principal product, exported to supply the Peruvian Viceroyalty demand (to feed large amounts of mine worker). This implied transforming the small cattle farms into big agricultural *haciendas*, which needed large amounts of labour, triggering migrations of people to the countryside, becoming an *agricultural peasant working class* serving landowners under despotic labour conditions (Salazar, 2011). Taking into account the conceptual framework several elements of EUE can be distinguished. First the relation *centre-periphery* is present: Chile would be the periphery and the Viceroyalty the centre. As Chile was mainly exporting but not importing, a material trade deficit can be assumed, which is the basis of EUE. Two essential elements are how the external sector organizes the internal economy and society, and how the benefits would unequally be distributed (land owner versus peasant), according to the framework both are characteristics of EUE. Nevertheless, as the production was organic and possibly not so large scale, the environmental impacts can assumed to be small. But due to the material deficit, uneven class benefits and external pressures to organize the local economy, Chile was probably having EUE.

Since the second half of the XIX century and until the present, Chile's principal economic activity has been the mining sector. Figure 2 shows Chile's mineral production in biophysical terms (volume tonnes) from 1860 to 2014. The figure would vary considering monetary income generated

by the minerals. Nevertheless, as explained in the theoretical framework, for EUE it is more important to analyse the physical levels of extraction.

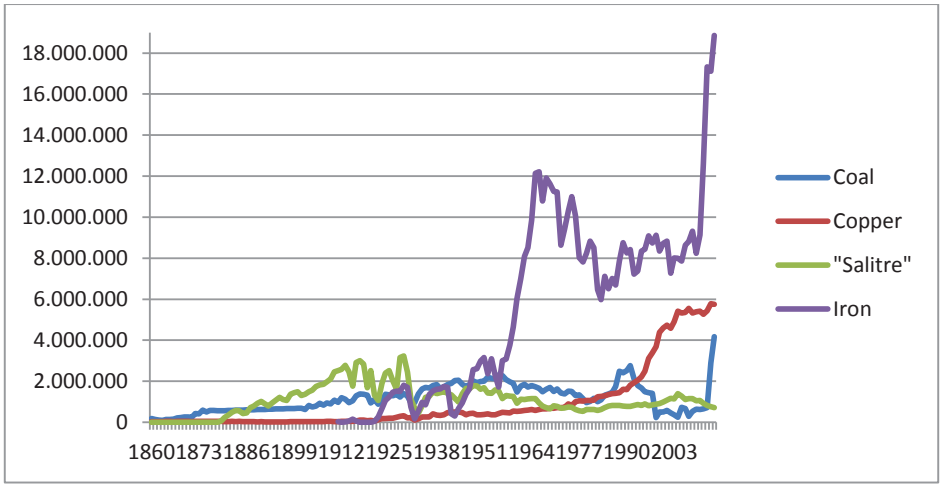

Figure 2: Chile's main mineral production in tonnes, for the year 1860 to 2014. *Source: Own Creation based on statistics from Catholic University historical data, COCHILCO databases and yearbooks, and SONAMINERA Mining Bulletins.*

Coal was Chile's first important mining product. It was produced mainly in Bio-Bio region (Lota) and was used to fuel steam ships arriving to the continent, trains (transporting mainly minerals), national industries (principally mineral smelting) and for export (Mazzei, 1997; Mendoza, 2008). Thus, coal was strongly connected to the international markets through mining products to be exported. The exploitation labour regime in Lota was brutal[13], and led to one of the biggest fortunes the country has had: the Cousiño-Goyenechea family (also owning several other companies). This family was in their moment even considered as the richest family on earth (Rojas and Imas, 2015). Coal demand fell in the second half of XX century when it was replaced by other energy sources, producing huge unemployment in the area. From a EUE perspective coal case is interesting. We have again the strong relation of the external demand organizing the national economic structures. The impacts of coal extraction were in part to fuel the mining industry and its transportation. And the class distinction is also present. Thus, it can be considered to have a great socio-environmental impact embodied.

Salitre (natural Sodium Nitrate) became in the late XIX and early XX century an extremely important industry, and Chile was world biggest producer. *Salitre* was used to produce powder (weapons) and fertilizers, thus it was a very attractive material. The industry was located in the desert, mainly privately owned by English capitalists, and production was almost completely exported to Europe. During its rise, *salitre* represented over 70% of Chile's total monetary exports and 30% of the GDP (Meller, 1996), but its exports had embodied an immense social cost. With the industry a vast mining-proletariat arose, together with one of Chile's worst labour exploitation regimes and the first massive worker movements (as well as massive repression); while in parallel

[13] But at the same time hospitals and schools were built for the workers families; and coal extraction fuelled the national mining industry, led to factories and for example the installation of the first telephones of the country (1877) and the second hydroelectric plant of South America (1897) (Valdebenito, 2008; Muñoz, 2013).

immense fortunes were created (Salazar, 2003). The invention of artificial *salitre*[14] and the crisis of 1929 dismantled and buried completely the industry. Production peaked in 1929 with 3.2 million tons, and felt in few years 87% (to 438 thousand in 1933), leading to severe unemployment, poverty, forced migrations from the mines to the cities, leaving hundreds of mining ghost towns in the desert, raising urban marginality and producing one of Chile's historical worst social crisis. This is a clear example of how Chile's welfare depended completely on its relation with the international economy. From EUE perspective, as production took place in the dessert it is difficult to consider the environmental impacts. But the social impacts where overwhelming. The class issue is strongly present; as well as how Chile's economic activity is organized and depends from abroad. Owners were even mainly British capitals, strengthening the *centre-periphery* relation.

In the second half of the XX century iron started being mined intensively in Chile. It was a strategic sector to promote Chile's industrialization[15], becoming the keystones of the *national-development plan* guided by the State inspired by ECLA policies (substitute importations), with the objective of decrease dependence to global industrial centres (not reliable after WWII), and therefore decreasing unequal exchange. Iron became by far Chile's biggest mineral extraction, position it has maintained until the present. Industrialization policy was weakened in the 1960s, and later iron was privatized during the dictatorship (1973-1989). Details of Chile's iron history can be found in Millán (1999). Since the late 1990s iron extraction has grown strongly again, but not focused on industrialize, but focused on exportation of iron ores to be processed abroad, in detriment of national industries (Salazar, 2011). At the present, iron is Chile's biggest mineral extraction (over 18.8 million tons in 2014), but as I will discuss in the result section, the industry is not free of environmental impacts.

Copper is Chile's present most known export product, and the country is one of the biggest producers and exporters in the world. The industry grew with the expansion of the electric and building sector in the XX century. Copper is considered Chile's most important source of foreign currency (US$), needed to import products and payback debts. Copper was opened to private investments (from developed countries) during the dictatorship and grew strongly since the late 1980s, reaching over 5 million tonnes in the 2010s (Figure 3). Nevertheless, copper is neither free of environmental impacts (also discussed in the results).

In conclusion, since the colonial period Chile's main economic sectors (cattle, wheat, coal, *salitre*, iron copper) have been basic products (raw materials), thus the country has had historically a strong role of periphery (not semi-periphery). Chile's socio-economic organization has been ordered from its relation with *centre* (the global markets), just as suggested in the framework. The exported products have had a great social impact embodied, and, as they were all raw materials, we can assume they also had a strong environmental impact. Therefore, according to what discussed in the literature review, Chile's historic trade show clear insights that the country could have been having Ecological Unequal Exchange relations since its colonial period.

[14] Synthetic *salitre* was a German invention. Paradoxically, Rivera (1994) suggests synthetic nitrate was created inside Chile, in the German nitrate companies ("Officina Alemania"), and ended producing one of the worst historical socio-economic crises in the countries.

[15] Iron and steel are essential to support, created and promote the creation of industries and build infrastructure.

4.2. Chile's trade since the second half of XX century

During Pinochet's dictatorship in the 1970s a neoliberal model was implemented in Chile. Deep economic reforms were done pointing to freeing the markets from any intervention. The state was minimized, private investments promoted, financial markets liberated, price controls eliminated, regulations reduced, labour unions repressed, and the economy started a non-precedent opening process to international trade (French-Davis, 2008). In parallel the State was dispossessed of its public goods, companies and natural resources. Minerals, forests, steel plants, water rights, electricity, as well as services such as health, education or pensions were privatized. At the present Chile has 25 free trade agreements with more than 60 countries and country unions (Direcon, 2016), being one of the countries with most FTA in the world. This reflects the political importance of neoliberal school and the competitive advantages theory in Chile.

As determined in the framework, to approach EUE I will analyse trade based on *biophysical* terms (material flow exchanged in tonnes), which is an approach to the *embodied nature* traded. Figure 3 shows the evolution of Chile's material import and exports (in tonnes) between 1962 and 2014. Trade have increased strongly since the 1980s driven by the neoliberal model, and reflecting the country's insertion in the global economy (e.g. the free trade agreements and lowering duties). In 2014 Chile's physical trade was approx. 5 times bigger than in the 1960s. But the most important aspect for EUE is that exports have normally been bigger than the imports reflecting an *ecological deficit*, which I will analyse in the result section.

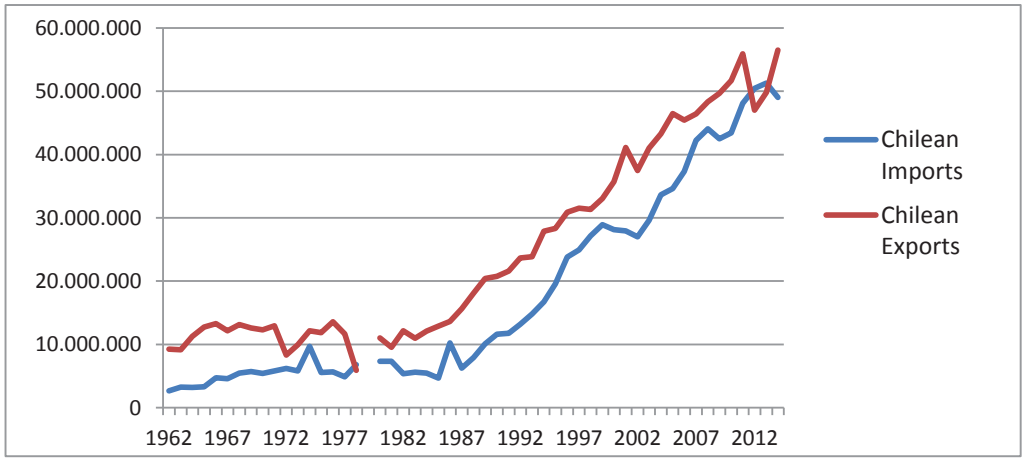

Figure 3: Chilean Material Imports and Exports (in tonnes) between 1962 and 2014. *Source: Own Creation based on calculations with statistics from ECLA-badecel and UN-comtrade databases.*

Table 1 shows Chile's exportation structure (in volume and monetary terms) for some selected years[16].

Table 1: Chilean exports in volume (tons) and real expenditure (US$, 2014)								
SITC - Rev. 1	1962		1982		2002		2014	
	Volumen (ton)	US$ (2014)	Volumen (ton)	US$ (2014)	Volumen (ton)	US$ (2014)	Volumen (ton)	US$ (2014)

[16] The analysis is based on the categories from the Standard International Trade Classification Revision-1 (SITC-Rev.1), which is used by international institutions to classify and analyse world trade.

0 -Food and live animals	2,6%	6,0%	12,1%	18,5%	11,5%	23,8%	9,4%	19,4%
1-Beverages and tobacco	0,1%	0,1%	0,1%	0,5%	1,4%	3,6%	1,5%	2,6%
2 - Crude materials, inedible, except fuels	89,5%	23,2%	73,1%	25,9%	49,9%	22,8%	61,7%	33,5%
3 - Mineral fuels, lubricants and related materials	0,0%	0,0%	1,4%	2,0%	3,0%	1,2%	4,7%	0,9%
4 - Animal and vegetable oils, fats and waxes	0,2%	0,5%	0,7%	0,8%	0,1%	0,1%	0,2%	0,3%
5 - Chemicals and related products	1,0%	1,7%	1,6%	2,2%	11,5%	6,2%	5,4%	4,6%
6 - Manufactured goods classified chiefly by material	6,5%	67,5%	10,8%	48,1%	19,1%	34,0%	16,7%	33,7%
7 - Machinery and transport equipment	0,1%	0,3%	0,1%	1,5%	0,3%	2,5%	0,3%	3,5%
8 - Miscellaneous manufactured articles	0,0%	0,0%	0,0%	0,3%	0,2%	1,5%	0,1%	1,5%
9 - Commodities and transactions not classified elsewhere	0,0%	0,3%	0,0%	0,1%	3,2%	4,4%	0,0%	0,0%
Total	**9.247.991**	**$ 3.141.429**	**12.147.074**	**$ 7.614.902**	**37.472.368**	**$ 39.596.893**	**56.489.927**	**$ 75.572.518**

Table 1: Chilean Exports in volume (tonnes) and real expenditure (constant US$, 2014). *Source: Own Creation based on calculations with UN-Comtrade and ECLA-badecel databases, following the Standard International Trade Classification - Rev. 1. Real income from exports was calculated using the GDP deflactor, from Chile's Central Bank.*

In material terms, Chile's most important exports since the 1960s are raw materials (category 2)[17], reinforcing the historical trend. Regarding income, the most important is Manufactured Goods (Category 6). Manufactured Goods have increased strongly since the 1960s, both in income and volume share. Food related exports (Category 0) based principally on fish, grapes and apples, and wine exports (Category 1) have also increased strongly. The diversification since the late 1970s of Chilean export has strongly been based on these last two categories and impulse by the market policies. The main destination of Chilean exports are China, where 17 million tons of products were sent in 2014 (18.9 billion US$) and the USA with 11 million tons (9.1 billion US$).

Nevertheless, there is a very important point to be clarified to avoid confusions. The increase in manufacture category does not represent an industrialization process of the country. Among those manufactures (Category 6) we find products such as refined, blister and alloys of copper, and *simply shaped or worked* wood. After adding a small industrial process these products are considered as "manufactured products". However, for the author these kinds of products, despite their embodied *industrial process,* should (and will on this thesis) be considered as forms of raw materials. To illustrate their importance blister and refined copper (items 68211 and 68212 in SITC) together with simply shaped wood (6318) represents 77% of the volume and 84% of the income of the manufactured products (Category 6). Therefore, it is possible to affirm that the country is extremely dependent on its production of raw material, which is very relevant for EUE because this category usually has a much stronger socio-environmental impact embodied than other categories.

[17] Very interestingly, since 2013 coal exports have grown more than exponentially: from 31 tonnes in 2012 to 1.9 million tonnes in 2014, becoming one of Chile's principal export products. Just as iron, the renaissance of coal industry is focused on exports. Coal is an important element to take into account for future EUE studies.

Table 2 shows Chile's imports structure for the same selected years.

Table 1: Chilean imports in volume (tons) and real expenditure (US$, 2014)								
SITC - Rev. 1	1962		1982		2002		2014	
	Volume (ton)	US$ (2014)	Volume (ton)	US$ (2014)	Volume(ton)	US$ (2014)	Volume(ton)	US$ (2014)
0 -Food and live animals	22,3%	17,6%	32,6%	13,4%	13,1%	7,2%	11,9%	7,1%
1-Beverages and tobacco	0,1%	0,4%	0,3%	1,5%	0,0%	0,3%	0,5%	0,6%
2 - Crude materials, inedible, except fuels	4,2%	7,0%	2,4%	2,4%	2,7%	1,9%	2,8%	2,0%
3 - Mineral fuels, lubricants and related materials	51,8%	6,5%	47,9%	17,9%	63,4%	16,5%	60,0%	21,2%
4 - Animal and vegetable oils, fats and waxes	0,9%	1,3%	1,7%	1,4%	0,3%	0,3%	0,8%	0,7%
5 - Chemicals and related products	9,1%	8,7%	5,9%	9,6%	11,1%	13,0%	7,9%	10,7%
6 - Manufactured goods classified chiefly by material	6,2%	12,7%	5,1%	12,9%	8,3%	13,8%	13,1%	11,7%
7 - Machinery and transport equipment	4,8%	39,6%	3,2%	30,1%	0,5%	35,2%	2,3%	34,0%
8 - Miscellaneous manufactured articles	0,6%	5,9%	0,8%	10,7%	0,6%	11,3%	0,8%	12,0%
9 - Commodities and transactions not classified elsewhere	0,1%	0,2%	0,0%	0,0%	0,0%	0,5%	0,0%	0,0%
Total	**$ 2.682.152**	**$ 3.045.659**	**$ 5.373.568**	**$ 7.369.919**	**$ 26.999.319**	**$ 34.960.234**	**$ 49.033.708**	**$ 72.343.624**

Table 2: Chilean Imports in volume (tones) and real expenditure (constant US$, 2014). *Source: Own Creations based on calculations from UN-Comtrade and ECLA-badecel databases, following the Standard International Trade Classification - Rev. 1. Real income from exports was calculated using the GDP deflactor, from Chile's Central Bank.*

Historically, Chile's biggest import in biophysical terms has been fossil fuels (category 3). At the present (2014), fossil fuels represents 60% of Chile's material imports (21% in monetary terms). In fact, 63% of Chile's primary energy source corresponds to imported fossil fuels (Subsecretaría de Energía, 2015). The second biggest material imports are manufactured goods (category 6: 13%) followed by food products (category 0: 12%). Nevertheless, in monetary terms the most important products are machinery and transport equipment (category 7: 34% of expenditures). This structure is representative since the 1960s. The main sender of Chilean imports is the USA with 23% of the material imports (20% monetary terms) and second China with 8% (and 21% monetary). The physical-monetary difference is explained because China sends principally manufactured products, while from USA 76% are fuels (category 3) which has a lower price than manufactured goods. Other important origins of Chilean imports are Japan, Argentina, Brazil and Rep. of Korea.

At a global level Chile's most important products imported (in material terms) between 1962 and 2014 are *petroleum, coal, gas, wheat, maize* and *nitrogen fertilizers*; *cement* became important since

the 1990s, as well as *inorganic acids* since the 2000s[18]. Thus, the country imports mostly fossil fuels.

Regarding the EUE analysis, considering Chile's main import is fossil fuels, it is highly probably that the country is importing a big environmental impact. The social impact imported would depend on the country sending the products. Nevertheless, to make a more accurate analysis more information is needed, and that is what precisely I will present in the next section.

4.2.1. Income Gap

Since the XX century the income gap has become one of the main aspects to compare uneven development and thus, as explained in the literature review, the objective of unequal exchange theory[19]. The idea behind the income gap is that countries do develop economically (grow, increase their income), but some countries grow faster than others. Therefore, the gap between them will increase, i.e. inequality rise, implying that poor countries would never catch up with the rich ones.
Figure 4 shows the income gap between Chile and the USA between 1940 and 2014, and it is possible to see that the gap has widened over time. Both countries have grown in the period (both are richer), but seems that USA has grown faster than Chile. In real terms Chile's per capita GDP at the present (2014) equals USA's in 1942.

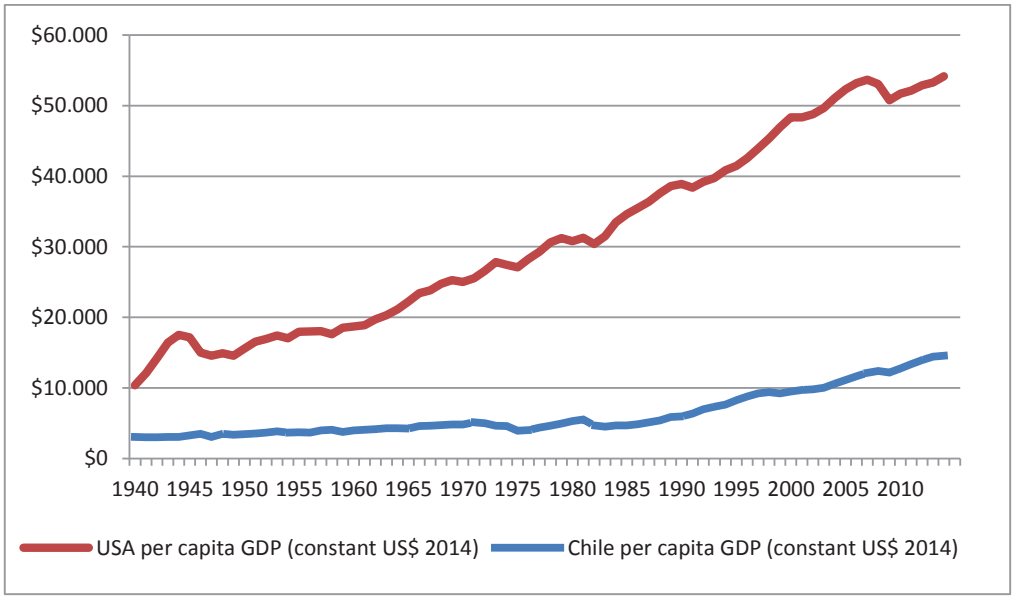

Figure 4: Income Gap between Chile and USA, in per capita GDP at constant US$ 2014, between 1940 and 2014. *Source: Own Creation based on calculations with statistics from U.S. Bureau of Economic Analysis, IMF data, Chilean Central Bank and UC historical data.*

Chile's income gap with the USA reflects that ECLA's discussion of the 1940s (and after unequal exchange theories' discussion) is still at the present valid for Chile: developing countries are not catching up with the developed ones; instead, they are becoming even more distant. Relating this with the framework, the income gap suggests that the neoliberal economic policies promoted to

[18] For the SITC-Rev.1 categorization, the code of the products are the following: Petroleum (SITC-Rev.1: 3310), coal (3214), gas (3411), wheat (0410), maize (0440), nitrogen fertilizers (5611), cement (6612) and inorganic acids (5133).
[19] It can also be considered as the first evidence of a possible unequal exchange relation

develop Chile, based on the competitive advantages, have not been enough to develop the country. This suggests that Prebisch's questions of the 1940s are still valid: *Why are countries not catching up? What can they do to catch up?* Or as I will try to clarify in this thesis: *is EUE one of the reasons behind the gap?*

Thus, from an historical perspective we can conclude that Chile has had an historical role of periphery exporting raw materials, and importing mainly energy to produce those raw materials. Despite there are no information regarding the environmental impacts, it is possible to suspect them to be high due to they are all raw material extractions. Also, we can see there had been some groups benefiting from trade and becoming extremely rich, while others have been strongly impacted. Or that the internal structure of the country has been organized from its external relations. And despite increasing its raw material production (comparative advantages), the country is not catching up with the developed economies, increasing international inequalities. Thus, the bases to suspect Ecological Unequal Exchange relations are present. In the next section I will explore Chile's possible EUE in the XXI century.

5. Results

After discussing a general vision of Chile's trade structure and its historical evolution, I will present the results of my empirical research, i.e. more detailed information regarding trade, which will be the basis of the Ecological Unequal Exchange analysis. To be synthetic, I will only present the most relevant facts, and leave general information on the Appendix section. In the Analysis section I will discuss the results based on the theoretical framework.

5.1. Balance of Trade

Figure 12 in the Appendix shows the **Monetary Balance of Trade**, which reflects how much money flows in and out from the country, and is used normally in economics to analyse exchange. Since the 1960s it has been equilibrated, with some periods of great monetary surplus during the early 2000s. This suggests Chile is having an outstanding trade performance. Nevertheless, as explained in the literature review, for EUE the relevant is seeing how much biophysical materials are flowing out and in (material flow analysis), and not focus on monetary terms. The material flow is reflected by the **Material Balance of Trade** account (Giljum, 2004) and is calculated as the material flowing into the country less the material flowing out from it[20]. Figure 5 shows Chile's material flow since 1962. As Chilean exports have constantly been higher than the imports (Figure 3), Chile has a constant material deficit, which is seen in the negative values of Figure 5.

The biophysical deficit is the basic clue to start suspecting about an Ecological Unequal Exchange. There is more biophysical material flowing out of the country compared to how much is flowing in. And as explained in the literature review, this means that Chile is subsidizing the consumption of nature other countries are having; and therefore, those countries would have an ecological debt with Chile. Although the deficit is a prerequisite, it is not enough to state EUE. Therefore I will go further on a deeper analysis with details regarding exports and imports.

[20] [Imports (ton) - Exports (ton)]

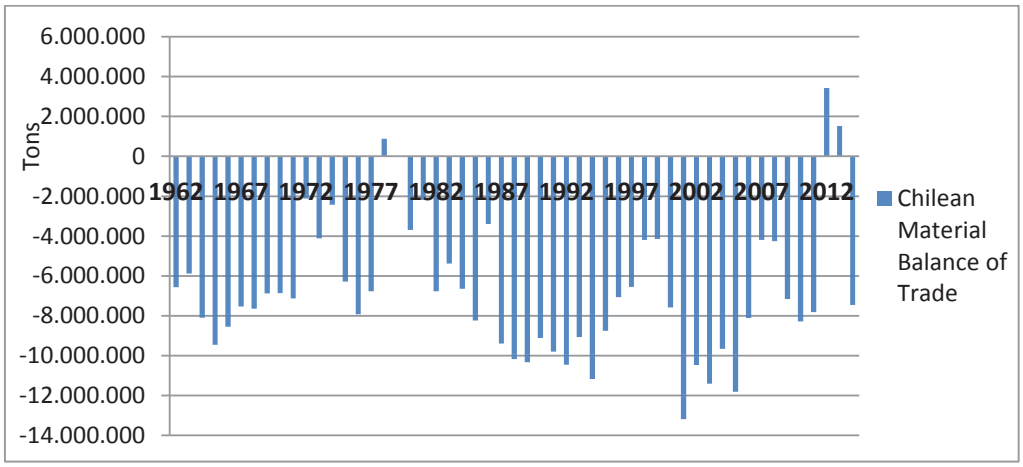

Figure 5: Chilean Material Balance of Trade, in tonnes. *Source: Own Creation based on statistics from ECLA-badecel and UN-comtrade.*

5.2. Chiles main exportation and importation products

As discussed in the literature review and methodological sections, to make EUE studies specific information regarding all the countries trading is needed. But due to the immense amount of products exchanged it is not possible to analyse them all. Therefore, in this thesis I will focus on Chile's main exportation products. After analysing Chile's biophysical trade between 196 and 2014, I identified the four main products exported: *Iron*, *Copper*, *Salt* and *Wood*[21]. Figure 6 shows the production trend (in biophysical terms) of these products (and Figure 13 in the Appendix shows their monetary trend).

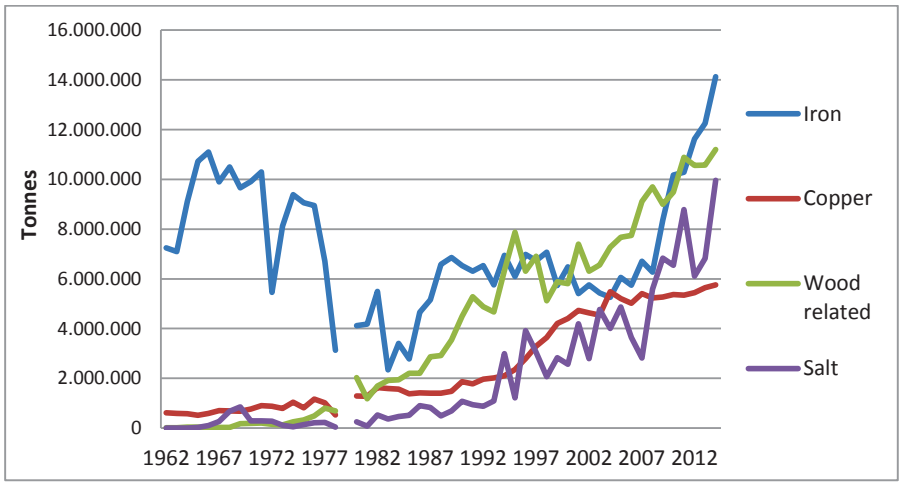

Figure 6: Chiles' main four exportation products (in tonnes) between 1962 and 2014. *Source: Own Creation based on calculations with statistics from ECLA-badecel and UN-comtrade databases.*

These four products constitute 64% of Chile's exports between 1962 and 2014, and 73% in 2014 (Figure 14 in the Appendix), therefore they can be considered representative to make a EUE

[21] Coal became in 2013 an important exportation product. As it is something too recent, coal will be excluded from the analysis. However, it is important to mention it to have it into consideration for future studies, and follow its development as a new possible important export of the country.

analysis. It is essential to note that the four products are raw materials, and interestingly Chile is among the world leader producers in all of them. A detailed analysis of these four products is presented in the Appendix (4. Copper, 5. Iron Ore, 6. Salt and 7. Wood Related Products) regarding their production trend since the 1960s, property of the production, and destination of the products. Here I will only present a summary of some important points.

Historically, the biggest important exportation product in biophysical terms is iron (14.123.717 tons in 2014), followed by *wood related products* (11.202.441 tons in 2014), salt (9.965.414 tons in 2014) and fourth copper (5.754.863 tons in 2014). Considering monetary terms the situation changes and copper is by far the most important of these four products (37.9 billion US$, 2014), while wood (4.4 billion US$), Iron (1.1 billion US$) and Salt (173 million US$) are much lower.

All the products have constantly increased their production since the 1960s, and all are privately owned, despite copper where approximately 33% is State produced (see 4. Copper in the Appendix section). And its production is almost completely intended to be exported (see details in the appendix). The main destinations of these four products have moved from being USA and Europe in the 1960s, to Asiatic countries in the 2000s. USA and Japan has kept their importance over time. China and Korea have become very relevant since the late 1990s, and Europe has decreased strongly its share since the 1980s (details are found in the Appendix).

5.3. Environmental and social impacts embodied in Chilean exports

For the Ecological Unequal Exchange study it is essential to analyze what environmental and social impacts the products exported has embodied on them, i.e. what Chile is really exporting hidden on those products. As discussed in the framework, due to cultural dimensions and particularities from each place, several of these impacts cannot be quantified (Hornborg, 2014; Bunker, 1984; Laclau, 1977). Thus, many will be commented qualitatively through cases. Afterwards, to build the EUE analysis, I will compare the impacts exported by Chile with those imported from other countries.

5.3.1. General Socio-Economic Statistics about Chile

As explained in the background a general characteristic of Chile is its neoliberal model, which according to Harvey (2007) implies the transformation of the institutions, power structures, labour and social systems. As I will explain with cases, these elements can be seen in Chile and are strongly connected to its trade. Some relevant aspects to consider are the privatization of national resources and the privatization of the welfare systems (as education, health and pensions). Under neoliberalism labour relations became more flexible, externalization and informal labour increased, salaries decreased, working conditions worsened, exploitation increased and worker unions and movements were minimized through repression (Baeza, 2013). Society was commoditized. All these elements take place in the period of study and are embodied on Chile's exports.

Despite poverty levels in the country are not very high 14.4% (World Bank, 2015), and neither unemployment 6.3%, the inequality is one of the highest in the world (Lopez, Figueroa and Gutierrez, 2013). The GINI inequality index is 0.58[22] and the richest 1% of the population concentrates 30.5% of Chile's income. The per capita GDP was in 2013 US$ 15.723, and according to the Central Bank (2015) Chile's external debt equals 68% of its GDP (US$ 148 billion). As it is

[22] GINI index: 0 is completely equal and 1 is completely unequal.

explain in the literature review debts are an incentive to increasing trade (thus to EUE) in pursuit of foreign currency to pay debts back (Dos Santos, 2015). Furthermore, Chile contributes with 0.2% of world CO_2 emissions (CDIAC, 2015), being 4.5 tons CO_2 equivalent per capita (2011) (World Bank, 2015). These elements are relevant to be compared with the countries Chile is exchanging with.

5.3.2. Mining Socio-environmental impacts

Mining products are Chile's main export (Iron, Salt and Copper) contributing with many benefits to the country but also with many socio-environmental costs. Mining produces large amounts of waste material. Per each ton of copper produced, 130 tons of waste is produced (calculations based on SERNAGEOMIN, 2014). According to Giljum (2004), waste should also be accounted in the material flow analysis (in the EUE analysis). Part of this waste (the most toxic) is deposited on tailing dams, representing an immense danger for nature and society. According to SERNAGEOMIN (2016) there are 718 tailing dams in Chile: 124 active, 437 not-active, 32 without information and 125 abandoned. Dams are abandoned when the companies declare themselves conveniently in bankrupt; thereafter no one is responsible for them. Considering Chile is a highly seismic country dams represent a major risk. Paradoxically the country discusses about how to increase copper production to increase the income (monetary value), but not about the waste produced and its risks (social and biophysical values). Considering that in the future (e.g. 100 years) many of the present mining companies will probably not exist, their tailing dams will be abandoned, and their risk will be much higher (how can this be quantified and accounted to EUE?).

Water use by mining constitutes also an important impact. In one hand the large amounts of water used by the activity, hinders human and agricultural consumption. Considering the activity is mainly located in dry areas (deserts) and that the country is facing one of the worst droughts in its history water use constitutes a major problem. In the other hand, underground water is frequently polluted, affecting neighbor communities and wild-life depending on those water sources. Heavy metals as mercury, arsenic, lead, copper or manganese are filtrated into water and soil, and the long term exposition to them produces several diseases, many deadly, to humans and animals.

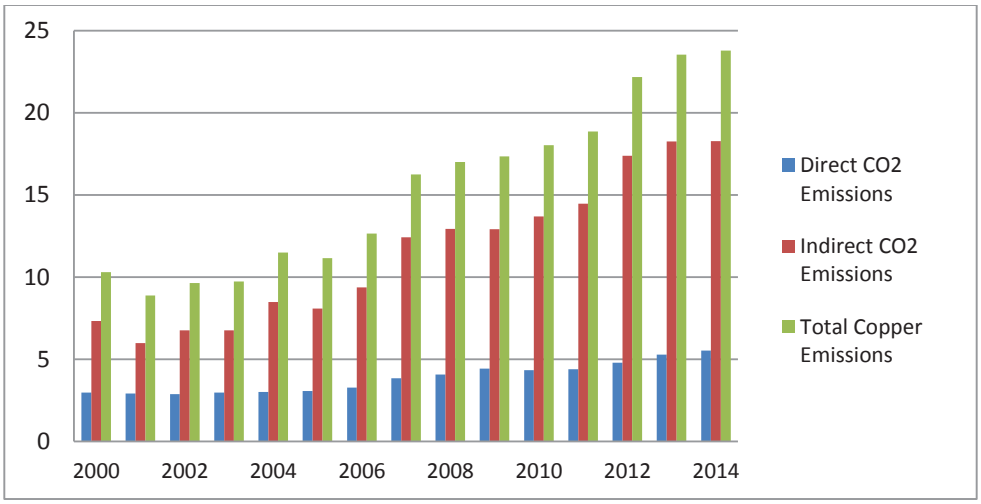

Figure 7: Chilean Copper direct and indirect emissions, in Million Tons of CO2 equivalent, between 2000 and 2014.
Source: Own Creation based on statistics from COCHILCO, National Energy Commission (CNE) and own estimations.

The only quantitative impacts of the mining sector I could quantify are related to energy use and air pollution. Chile's mining sector uses 11% of the country's total energy: 51% comes directly from fossil fuels and 49% correspond to electricity, which is indirectly also mainly fossil, as thermoelectric (Subsecretaría de Energía, 2015)[23]. Copper, by itself, consumes 8.4% of Chile's total energy supply, and iron 0.5%. Therefore, the mining industry has huge air emissions embodied contributing to global warming. Figure 7 shows how copper GHG emissions have progressively increased since the year 2000. Direct Emissions are those related with the industrial process (extraction and manufacture), while indirect emissions are those related with the use of electricity[24].

As the mining industry expands, more environmental impacts are generated, and thus social unrest grows proportionately. The reaction to socio-environmental conflicts is frequently violent protests by affected people. However, in 2009, after 27 years of "discussion" in the parliament, Chile subscribed to the International Labour Organization Convention N° 169 regarding Indigenous and Tribal People (ILO 169). This convention mandates by law that all investments (public and private) that could affect tribal people must first be approved by those communities. Since its approval, ILO 169 has become a legal weapon of the communities to struggle against the mining industries, increasing substantially the legal prosecution of these projects. Related projects, as energetic projects (thermoelectric and dams) aimed to supply the mining industry are also being persecuted. The success tribal people have had stopping industrial projects has incentivized non-indigenous communities to also oppose and legally prosecute those projects (but not under ILO 169). This legal phenomenon has been reinforced through the expansion of knowledge regarding the mining activity's impacts among the population. People know that the projects will pollute their water, air and soil, affecting their agriculture and health. Projects are also considered to invade indigenous land and transgress their religious or ceremonial areas, disrupting their traditional cultures (RT, 2014; OLCA, 2011). The result of legal prosecution has been 60 big mining and energetic projects stagnated in courts, equivalent to US$ 70.000 million (Guerrero Olivos, 2014).

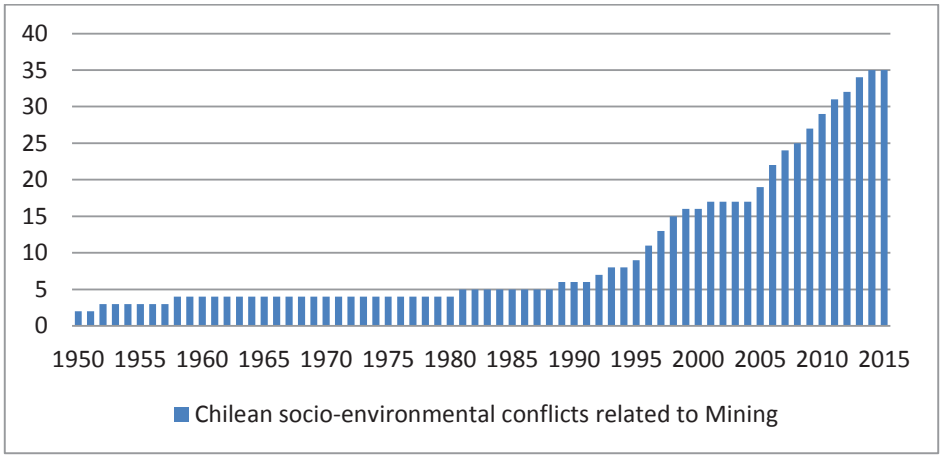

Figure 8: Chilean accumulated Socio-environmental conflicts related to the mining industry, between 1950 and 2015. *Source: Own Creation based on data from OLCA and EJOLT databases.*

[23] Copper, by itself, consumes 8.4% of Chile's total energy supply, and iron 0.5%.
[24] Indirect emissions since 2010 are own calculations based on the energy consumption of the mining sector and the carbon footprint suggested by the Energy Ministry of the country. There is no national official data available regarding indirect emissions after the year 2010, despite Copper is Chile's principal income source.

Figure 8 shows the increase of socio-environmental conflicts related to mining since the 1950s, based on data from the Latin American Environmental Conflict Observatory (OLCA, 2015) and Martinez-Allier's Environmental Justice Atlas (EJOLT, 2015); however, it reflects only the conflicts subscribed to OLCA and EJOLT networks, but as explained, there are many more. Following I will present some iconic socio-environmental cases worthy to be commented. Furthermore, as discussed in the framework, these cases will help explaining the non-quantifiable character of socio-environmental impacts.

1) There are several cases related to the risk of tailing dams. (i) In March 2015, after strong rain and alluviums, several tailing dams had toxic spills (SERNAGEOMIN, 2015) polluting water and soil. Pushed by the alluvium part of this toxic mud flooded neighboring cities, producing a health hazard. (ii) In 1965, after an earthquake, *El Soldado* mine's tailing dam (Disputada de Las Condes Company) collapsed burying the whole *El Cobre* town and killing its 200 inhabitants. The company was property of French capitals (Undurraga, 1987), and did not even pay a fine for the tragedy. (iii) The earthquake in 2010 collapsed *Las Palmas* gold mine's abandoned tailing dam in *Pencahue*. The company was property of F.J. Errázuriz, member of an important family of Chile's oligarchy (with presidential candidates, senators and several companies). This spill buried a complete family of the community under the toxic mud (Ecosistemas, 2015). In fact, people of the community did not even know they were living close to a toxic dam. As these there are many more examples.

2) The case of *Ventanas* community (V region) is an iconic example of air and water pollution causing a major health hazard. The copper refinery plants of CODELCO (State owned) polluted the ocean where fishers worked and poisoned the community's environment. Diseases increased exponentially. Today *Ventanas* is considered a "zone of sacrifice", meaning the State considers there is nothing to do to save it (OceanaChile, 2012; IEPE, 2012; and Casa Memoria, 2013).

3) A very polemic conflict is between *Caimanes* Community and *Pelambres* Copper Mine of Antofagasta Minerals Company owned by the Luksic group (the richest family in Chile). The community has been claiming the tailing dam "El Mauro" (the biggest in Latin America) polluted the estuary they used for consumption and agricultural production. After 12 years of legal dispute and several violent protests, harassment and bribes, the community wan the legal trial. In March 2015 Chile's Supreme Court of Justice ordered Pelambres mine to remove the tailing dam and to restore the natural cause of the estuary. Nevertheless, the mine refused to abide the court's decision and has continued its operations during the whole year with normality showing they are above the State (Trafilaf, 2015). Instead, the company has tried to negotiate "compensations" with selected members of the community and their lawyers (Correa, 2015) pursuing to break the community's unity and power (Flores, 2015: leader of Caimanes).

4) Barrick Company (Canadian capitals) had a very polemic episode with Pascua Lama-Mine in northern Chile and Argentina. The company impacted important glaciers and polluted underground waters. Both water sources were connected to the river systems used by many communities in the region, which is an important agricultural region of the country (Wiebe, 2015). After many protests the mine was sued in court by Diaguita and Aimara indigenous groups under the ILO 169, who managed to paralyze the project in 2013. Since then Barrik is still trying to restart it.

5) Other iconic case is Punta de Choros: as small fisher community living in a marine reserve considered one of Chile's main biodiversity hotspots. The community is facing the threat of a mega-project (iron and copper) called La Dominga, of Andes Iron Co (owned by PENTA Corporation: Chilean capitals). The expected socio-environmental impacts are destructive for the people and the natural reservation. The community is struggling against it, while the company has tried to convince them to accept different "compensations", while offering monetary finance to gain people's acceptance, and causing deep divisions in the community (Greco, 2015). The same community (Punta de Choros) had in 2010 another famous struggle against the thermoelectric plant Barrancones (by Suez Energy: Multinational Corporation). The objective of the project was to provide the growing mining industry of the region with energy (Hervé, 2011). As it was located very close to a natural reservation it generated massive protests over the whole country led by ecological groups. Finally, the project was cancelled by Chile's President.

6) Other polemic energetic project was HydroAysén in 2011 (of ENDESA Corporation: Spanish capitals), aiming to build a giant dam in the Patagonia to transport energy thousands of kilometres to the mines in the north of the country. The expected impacts were tremendous, so the project caused massive protests along the whole country and several court processes. Finally the project was cancelled by the government in 2014, but the company is still trying to restart it.

7) At the present a very problematic hydroelectric project is Alto Maipo (of Luksic group) located close to Santiago and expected to provide Pelambres mine with energy (also Luksic group, see point 3). A study leaded by Andrei Tchernitchin concluded that due to the building of Alto Maipo (only 10% has been built) the water of Maipo River was polluted with arsenic, lead, manganese and nickel. Thus, Maipo River's waters should not be used for agriculture. Furthermore, the river would not be fit for consumption in the next 50 years (Correa, 2016).

Like these cases there are several more in the country. Furthermore, as legal prosecution of the projects has increased so much there have been several politicians suggesting to modify Chile's agreement to the ILO 169 Convention to limit the power of the indigenous communities and guarantee security for the corporations (Martínez, 2009; Donoso, 2008; NME, 2013).

In all cases it is possible to see a duality: communities being affected and big capitals being benefited (State, and private: national and international). Interestingly, the mining industry is one of the principal incomes for the State, and is used to fund different public goods. This complicates the Ecological Unequal Exchange analysis regarding how to attribute the costs and benefits. Nevertheless, the main share of the income is privately owned, and has generated some of the richest families of the country. Closely related to these private fortunes, in 2014 and 2015, two major political corruption scandals were revealed. (1) The first was the so called PENTAgate. PENTA Corporation (property of Carlos Délano and Eugenio Lavín: Chilean capitals), the company trying to build the mine in Punta de Choros, financed illegally several politicians including the Subsecretary of Mining Pablo Wagner (second man of mining) during the legal application of the mining project. Finally the project was approved, and triggered a major political scandal. At the present Délano, Lavín and Wagner (all members of Chile's "high society") are under house arrest charged by corruption (La Tercera, 2015). (2) The second case is SQM Mining company (controlled by Julio Ponce, with Chilean and multinational capitals), which also financed illegally several

politicians including parliamentarians, presidential candidates and even presidents, mainly from the rightwing but also from the left (Fernández and Sepúlveda, 2015). These examples show the close relation of mining capital with politics in Chile (despite their political tendency) and explain why some politicians promote cancelling Chile's ILO 169 Convention, and also why the socio-environmental impacts are so big. This situation will be analyzed deeper in the analysis section.

Other impact embodied on mining production is regarding its labor regime. Chile's mining sector has a partial labor-outsourcing regime. In one hand there are workers with direct contracts with the company, strong unions and very high salaries. They are among the best paid workers in the country. But in the other hand, there are outsourced workers, having intermediate contracts with external companies, with much worse labor conditions and lower salaries. Thus, being more exploited. This has produced frequent protest in the mining sector against their labor regime. There are also big differences between big and small mines. In smaller mines working conditions and salaries are worse. An extreme example of this could be the 33 mining workers trapped for 69 days after San Jose mine collapsed in 2010 (Chilean capitals). Working stability is also a problem, because it depends on the price of the minerals. If it is low, unemployment rises in the sector, which was the case during 2015. A general problem of the labor conditions is that workers are also exposed to toxicity, as dust causing lung diseases. An example of the problematic relation between workers and capitalists is that in November 2015 the worker union of SQM-Salar sued the company for being illegally exploiting and exporting minerals from a salt lake and for having abusive practices with the workers (Seymour and Arias, 2015). Interestingly, in this case the worker union took side for protecting the salt lake from its own company. Furthermore, SQM-Salar had several previous trials for anti-worker-union attitudes.

It is also worthy to comment that the technology used to mine is imported from other countries. Therefore, there is a dependency on foreign technology reinforcing the centre-periphery relation. Finally, as almost all mineral production is exported, all these socio-environmental impacts can be considered to be exported as well. Thus, they are part of Chile's possible EUE. Interestingly, it is not possible to separate the environmental problems from its social consequences. Rather, both need to be analyzed together, just as discussed in the framework.

5.3.3. Wood related socio-environmental impacts

Forestry is mainly organized in the central-south of Chile, and has also large environmental impact embodied. As Alarcón (2015) explains, native forests are cleared to plant exotic and faster-growing species, as Pine and Eucalyptus. Pine is an invasive species colonizing native forests while eucalyptus consumes lot of water. These species are not endogenous in the country, and thus cause severe impacts in the soil and the water cycle. Soil becomes more acid and its fruitfulness is affected, thus repopulation of native species is hindered. Water scarcity is at the present a major problem in Chile. Droughts are severe, and are strengthened by the eucalyptus plantations (and also by agriculture), hindering other water uses as human consumption. Droughts and water scarcity are an essential problem part of the forest fires Chile witnesses each summer, many of them uncontrollable (El Dinamo, 2015). Approximately 270.000 families base their economy on the forests (Pazos, 2015), and are affected thus by droughts and forest fires. Furthermore, by affecting soil and water cycles, Chile's food security and sovereignty is also hindered.

As forest plantations are monocultures, they are more likely to be affected by pests. In those cases they are sprayed with pesticides, which also affect communities close to them. Nutrients and pesticides drain into groundwater and flow into the ocean disrupting marine ecosystems in the coastal border, and affecting fisher communities depending on them. Forest industry also destroys the habitat of animal and plant wildlife, hindering their survival in the area and displacing them. To transport the wood logs new roads need to be built where heavy trucks transit, disturbing nature and the small neighbor villages (Alarcón, 2015).

The pulp mill industry also has several socio-environmental impacts. It produces gas emissions, liquid discharges into water and solid organic waste polluting the environment and causing health diseases (Espinoza and Pizarro, 2001). Regarding air emissions, the pulp mill industry consumes 6% of Chile's total energy (15% from fossil sources, 18% electric and 68% biomass from the wood transformation process) (Subsecretaría de Energía, 2015). Although forest plantations absorb CO_2 from the atmosphere, the pulp process emits more than what was captured (Mancilla, 2015), thus contributing to global warming. As pulp mills pollute marine ecosystems several artisanal fisher communities have been affected. There are two cases that will help explaining these impacts:

1. In 2004 the pulp mill *Planta Valdivia* of Celulosa Arauco Company (owned by Angelini group: one of the richest families of Chile), polluted the Cruces River and a wetland which was protected. As result the blackneck swan colony living there died. This situation generated several protests, closing temporarily the plant. In 2013 the court found the company guilty of the charges (Alarcón, 2015; OLCA, 2015).

2. In 2005, CELCO pulp mill, also of Celulosa Arauco Company, were accused by artisanal fisher communities from *Laraquete* and *Arauco* of polluting the coastal border. Pollution would have disturbed the marine ecosystem causing the death of several benthonic species fishers made their living from, increasing in consequence fishers' poverty (EPES, 2013). Both communities denounced they have had several previous pollution episodes with CELCO during the last 30 years.

However, as these cases there are several more. There are many cases related with Mapuche communities (indigenous), who accuse forestry industry to impact their subsistence agriculture, thus their food supply and usage of medicinal plants, and also accuse them of invading their sacred areas (Seguel, 2015). Nevertheless, the biggest problem is regarding the historical land claims against the forestry industry. The industry was built on lands that until the XIX century were indigenous, and acquired by different farmers through processes not considered legitimate by the indigenous communities. These disputes have led to extremely violent conflicts in the area, causing the death of several people in different clashes. Due to the violence, the areas are now strongly militarized to control social unrest (Caviedes and Bustamante, 2015).

Aside from these socio-environmental conflicts, the forestry industry also has internal labour conflicts. The industry is organized in large corporations and also by small farmers, and part of the labour force is peasant. Just as in mining, labour externalization is also present in forestry. This has led to several protests and big strikes, demanding better salaries, working conditions and reformulating the externalization system. Alarcón (2015) explains a proletarianization process in the sector, where peasants have become forestry workers, and small farmers have become forestry peasants. However, as Alarcón (2015) explains, the technology used by the sector to produce is

imported. Thus, there is a dependency link with other countries through their need of technology, reinforcing the peripheral character of this sector. This point will be analysed deeper in next sections.

The forestry activity has been since the late 1970s been strongly promoted by the State through subsidies (DL 701) and tax exemptions (Alarcón, 2015; Segel, 2015). The objective was to strengthen pulp mill production. In parallel with the development of forestry sector and its socio-environmental impacts, big fortunes have emerged. Two are particularly important: Angelini and Matte families; both among the five richest families of the country. Both constitute a duopoly in the sector and concentrate 79% of Chile's forestry exportations (Medrano, 2014). At the present they are being investigated under suspicion of collusion in different paper related sectors (Seymour, 2015). Both families have more than 2 million hectares in dispute with the Mapuche people (Caviedes and Bustamante, 2015). And some of Angelini companies (as CORPESCA) are also part of the corruption case of illegal financing of politicians (Caviedes and Bustamante, 2015).

As a sad paradox, despite the huge wealth created by the forest industry, the regions where it is emplaced are the poorest regions of the country, with highest unemployment and emigrations (Seguel, 2015). E.g. in 2012, 46 thousand people suffered from water scarcity in the region, hindering their water and food consumption (subsistence agriculture). Finally, as the major share of forestry production is exported, all these impacts are part of the EUE relation.

5.4. Comparing Chile's trade

After analyzing Chile's exports I recognized three main destinations: **USA**, **China** and **Japan**[25]**.** For simplicity I will limit the empirical study to these three countries. Next steps will focus on what Chile is importing from these three countries. USA, China and Japan represent 33% of Chile's total biophysical imports, and 44% in monetary terms (details in Table 10 in the Appendix 8), thus 67% of the material imports will be left outside the analysis. Further studies should include more countries to increase the representativeness, as Korea, India and Brazil, which are other relevant trade partners. At a general level USA is by far the principal sender of Chilean biophysical imports, while China is the main destination of the monetary values related to imports (Table 10 in the Appendix 8). The difference is because USA sends principally fossil fuels, while China sends manufactures which are less biophysical weight but more expensive.

To build the EUE empirical study it is needed to compare Chile's biophysical imports and exports from China, USA and Japan. The detailed information regarding the imports from these three countries is found in the Appendix sections 9, 10 and 11), here I will present the synthesis divided by each country focusing on the period 2000-2014.

5.4.1. Trade with the U.S.A

Figure 9 synthesises the trade relation between Chile and USA trade for the years 2000 to 2014. The products analysed represent 65% of the total material exchange of Chile and USA between 2000 and 2014, thus it is a good approach to the trade, but not enough to make general conclusions.

[25] These countries represent the main destinations of Chile's general exports, but also the main destinations of the four products chosen to be analysed.

Chile mainly imports from USA Fossil Fuels (petroleum, coal and gas), Inorganic Chemicals, Fertilizers, Wheat and Maize. Between 2000 and 2014 these products represented 79% of Chile's the total importations from USA, and fossil fuels are by far the biggest component. Chile's main four exportation products represented 56% of the exports to USA in the same period, being Salt the biggest product. However, for 2014, iron, salt, wood and copper represented 80% of the materials exported to USA, thus the products are representative for the present trade.

As shown in Figure 9, between 2000 and 2014 Chile has exported 118.3 million tons and imported 95.7 million tons to the USA. Thus, Chile has a wide material trade deficit of 22.6 million tons with USA. As discussed in the framework, this deficit is the basis of EUE. Nevertheless, is not enough to state there is EUE, but it is needed to analyse the embodied impacts of the products traded.

All the imports from the USA have embodied different kind of impacts. Regarding fossil fuels, coal mining releases acidic materials polluting underground water sources, ending in rivers, lakes and the ocean. As plenty waste material is produced the land is left barren if proper measures are not taken (UCSUSA, 2015a). Miners can also be affected by black lung disease. Gas production also pollutes groundwater; and leaves the bedrock less stable, increasing risk of earth shaking (Moskowitz, 2015). Drilling oil disrupts wildlife (and their migration routes) and leaves land uninhabitable. Oil spills produce the loss of animal and plant life, increasing the risk of major environmental disasters. And refining petroleum emits GHG contributing to global warming.

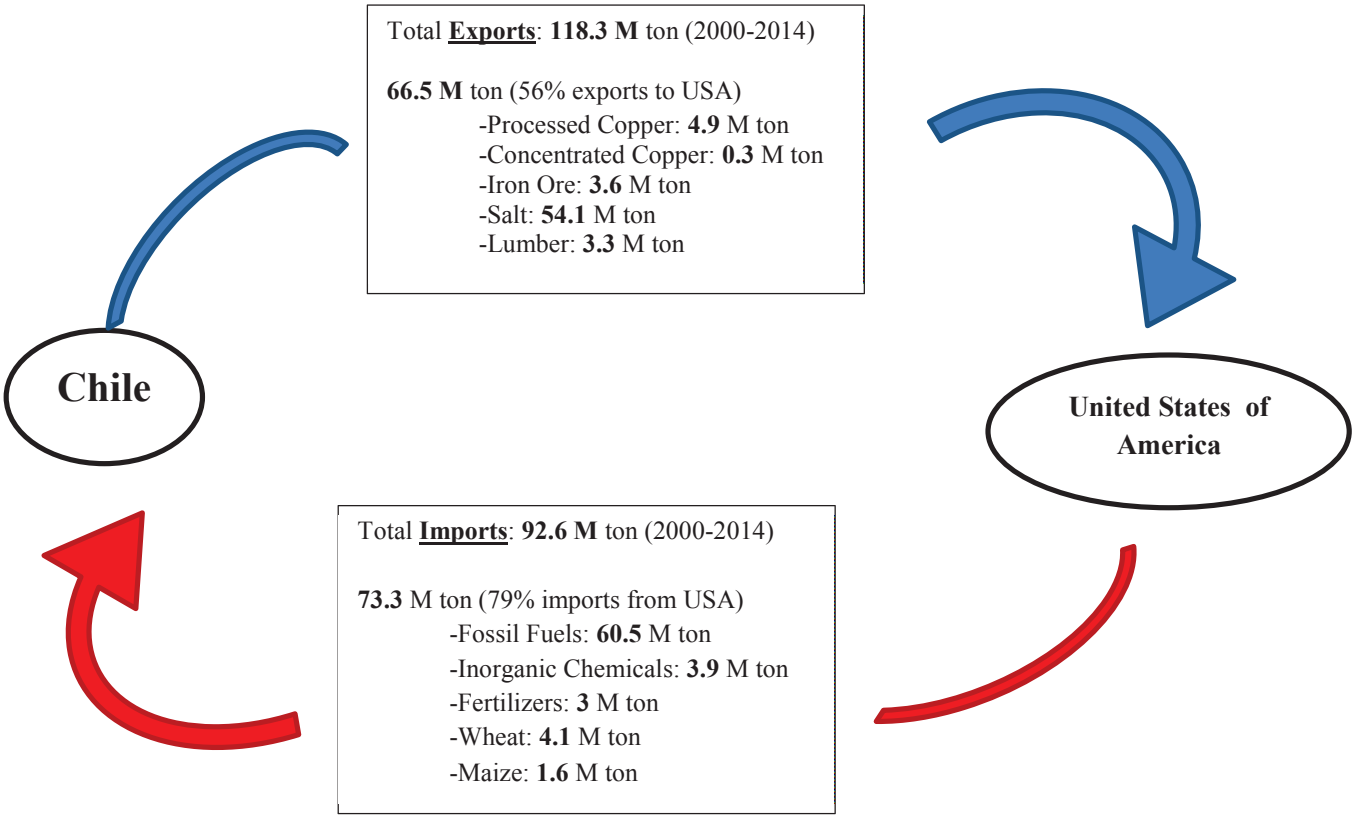

Figure 9: Synthesis of Chile's and USA's biophysical trade between 2000 and 2014 (in tons). *Source: Own Creation based on the results.*

The chemical industry is highly regulated; nevertheless it impacts nature through disrupting the natural chemical cycles (i.e. endocrines). Chemical pollution can cause several diseases and malformation in humans, animals and plants. Some impacts are also often unknown and unexpected (OECD, 2001). In its industrial process potentially dangerous waste is produced and in occasions released (to land or water) with unidentified long term effects. Once in the environment, chemicals spread in unexpected ways, converting into different substances. The industry also has indirect impacts through its intensive use of water and energy.

Wheat and maize production are monoculture crops and contribute to deforestation for clearing land, affecting the natural habitat of different animals and plants. Monoculture reduces biodiversity, and the intensity use of land produces soil erosion decreasing fertility. The reduction of biodiversity affects the ecosystems resilience, pushing a more intensive use of pesticides and fertilizers, some of them related with the collapse of bee-colonies (UCSUSA, 2015b), and also contributing to disturb the global nitrogen and phosphorus cycles (Folley, 2011). Many of the chemicals used pollute surface and groundwater (ending in oceans), disrupting ecosystems and threatening human health. Agriculture demands an intensive use of fresh water, which during droughts competes with other water uses. Genetically modified crops (as corn and wheat) are in the center of debates regarding their unknown impacts; and some companies as e.g. the Monsanto Corporation has been involved in several anti-competitive attitudes with small scale farmers (Giordano, 2002).

5.4.2. Trade with China

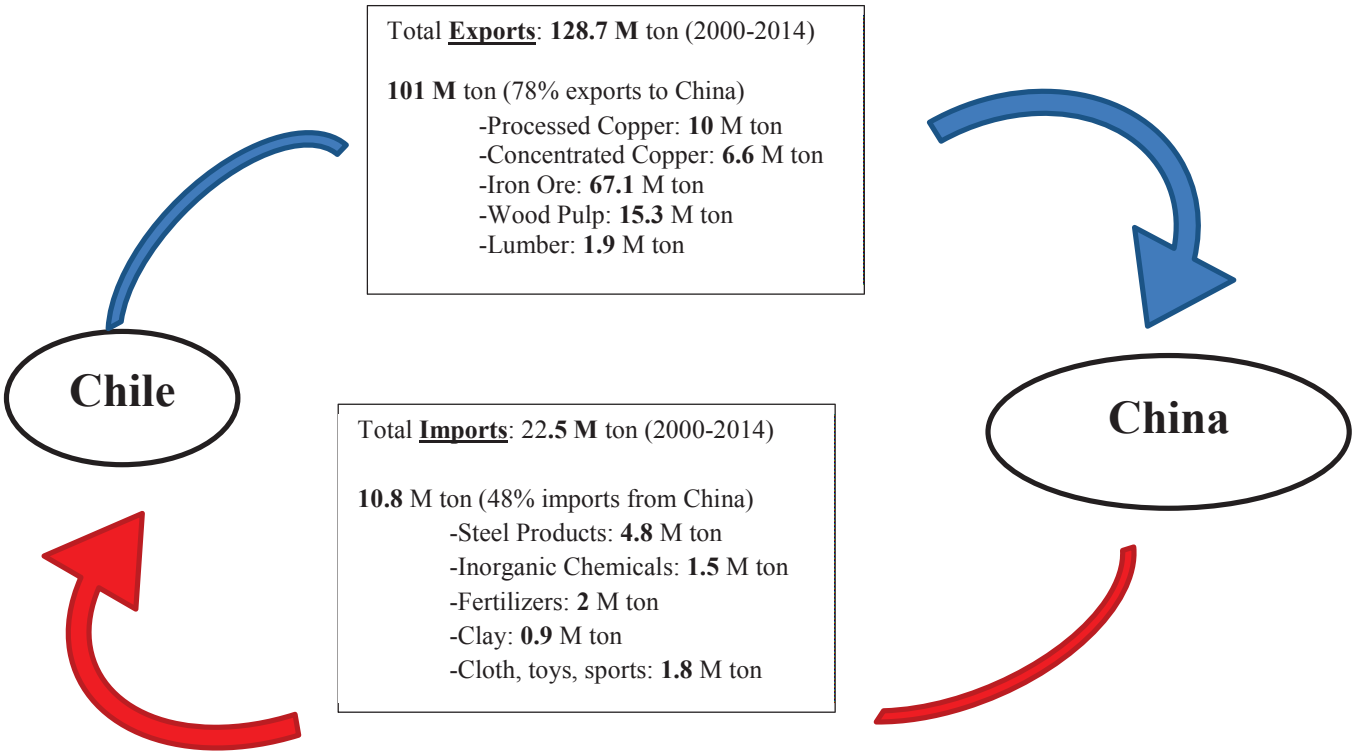

Figure 10: Synthesis of Chile's and China's biophysical trade between 2000 and 2014 (in ton). *Source: Own Creation based on the results.*

Figure 10 synthesises the trade relation of Chile and China between 2000 and 2014. In this period, Chile has sent 5.8 times more material to China than what it has received. Therefore, Chile has an extreme high trade deficit with China (106.2 million tons). The set of importation and exportation products I am analysing represents 74% of the trade between the countries, thus it is quite representative of the trade-relation[26].

Chile principally imports from China steel products, inorganic chemicals, fertilizers, manufactures (cloth, toys, sport products) and clay (the details are found in Appendix 10. Imports from China). These products represent 48% of Chile's total biophysical imports from China (28% monetary terms). As these shares are not so high, it reflects Chile is importing a very diverse set of products from China, being difficult to select few to be representative of the trade and complicating the EUE analysis. For example, as a category *manufactured goods* are the principal imports from China, but due to their diversity it is very difficult to incorporate them into the EUE analysis and I just took the main manufactures (clothing, toys and sport products). The second big category is chemicals (as fertilizers). But at an individual *product level*, Chile's principal import from China is steel related products (22% in physical terms).

In the 2000s Chile was principally importing cloth, toys and footwear from China. Nevertheless, importations started changing, and in early 2010s the main products were steel manufactures, construction materials and chemicals, reflecting the impact of China's industrial development and how it has strengthened relations with small and distant countries as Chile.

The products Chile buy from China have embodied immense social and environmental impacts. In the steel manufacturing process several GHG gases are emitted into the ait, as carbon dioxide (CO_2), sulphur dioxide (SO_2) and oxides of nitrogen (NO_x), contributing to local urban pollution (which is huge in China) and to global warming. The process consumes plenty water resource, which is after discharged into the environment together with solid waste, increasing toxicity in nature and affecting biodiversity. Itsubo and Inaba (2002) describe different sources of pollution of the steel process, and also the impact on different human diseases and disabilities (the study focuses on Japanese steel production though). Steel production uses plenty energy (plenty coal to reduce iron ores), thus, depending on the source of energy, the industry also have a vast indirect impact.

Regarding Clay, no major pollution problem was found regarding it; rather it is considered a safe material in its production and use (Greenspec, 2015a). Thus, it would not have environmental impacts contributing to EUE (although maybe social impacts). It is not granted the extraction of the raw materials takes places in the country or if it is imported, challenging how to trace its impacts.

Regarding the manufactured products, China is the factory of the world. Manufactured goods contribute to GHG emissions through their use of energy to produce them. China is passing by severe pollution cases, where smog in the cities has reached unexpected levels, causing major environmental degradation and health issues to the Chinese population. Nevertheless, it is not possible to isolate which part and how much of that pollution is related with the specific exports to Chile. In a general dimension, 36% of GHG from China are considered to be directly for export products, mainly to the USA (Lin et. al, 2014), and Chile receives just a very small part of it.

[26] For 2014, iron, salt, wood and copper represented 95% of the material exported to China.

Chinese exports do not only have a strong environmental impact embodied, but also a vast social cost. China's working conditions are deplorable, and several industries have been accused of violating labor and human rights, threating the working force as slaves, employing child labor, paying extremely low salaries, with workdays up to 15 hours in some places, forbidding labor unions, being an health-risk for their workers due to pollution, and with high risk of work accidents (as fires) for the low security inside the factories (Xu Lizhi[27], 2014; Blanding and White, 2015; Facing-finance.org, 2015; and China Labor Watch, 2015). Some companies (as Foxconn) even installed nets under the buildings to avoid workers to commit suicide. All these social impacts are embodied in the products they export to the rest of the world, being a key aspect in the EUE study.

5.4.3. Trade with Japan

Figure 11 synthesise the trade relation between Chile and Japan. From Japan Chile imports principally Inorganic Chemicals, Cement, Machines, Vehicles, Rubber articles, Steel and Iron products and Petroleum products (details in the Appendix section 11. Imports from Japan). Between 2000 and 2014 these products represented 98% of Chile's biophysical imports from Japan (82% in monetary terms). Chilean main export products (copper, iron, salt and wood related) represented 93% of the exportations to Japan. Combined these products chosen represent 93% of the commercial relation in biophysical terms (total material flow) between both countries. Thus, this trade analysis is highly representative of the relation between the countries.

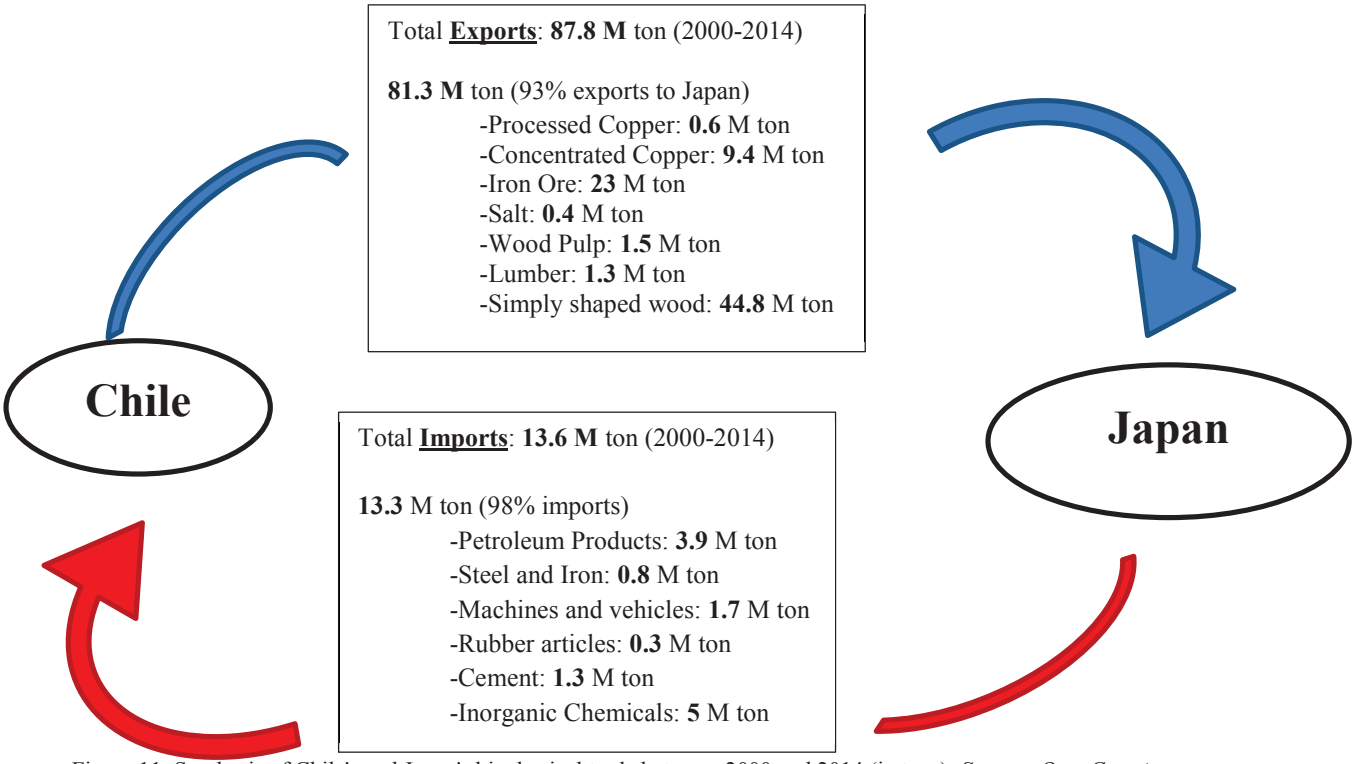

Figure 11: Synthesis of Chile's and Japan's biophysical trade between 2000 and 2014 (in tons). *Source: Own Creation based on the results.*

[27] Xu Lizhi (1990-2014), poet and Foxconn Worker who committed suicide repressed by the working conditions, and reflects the labour exploitation through his poetry.

Interestingly, Japan shows a big diversity in its exports to Chile, from technological machines to raw materials. The main products imported in biophysical terms were Inorganic Chemicals and Petroleum; but regarding monetary terms, Chile spent more in Motorized Vehicles and Machinery. These technological goods are more expensive than fuels, chemicals, or manufactured products (see Appendix section 11. Imports from Japan).

From Figure 11, Chile exports 6.5 times more material to Japan than what it imports, and has a biophysical trade deficit of 74.2 million tons (very similar to the one with China). But in order to have a better approach to EUE it is needed to analyse the socio-environmental impacts imported.

Japan has much lower socio-environmental impacts embodied in their products compared with China and USA. The main environmental impact of machineries and vehicles is related to the production of the materials needed in to produce them. This impact may not take place in Japan, but is imported (as steel, rubber, glass, plastic, paint; maybe some even come from Chile). Although the manufacture process consumes energy and contributes with GHG emissions, for cars it is estimated to be less than 12% of its total footprint embodied (Berners-Lee and Clark, 2010). Something similar happens with rubber, whose main impact comes from the extraction process (which may not take place inside Japan). Its manufacture impact is based on energy consumption and its GHG emissions. In the case of cement it is not clear if the country goes through its whole process, or if it imports the raw materials (mining). Nevertheless, producing cement contributes with immense emissions. The industry is the third biggest GHG contributor (after energy and transport), with a share of 4 to 5% of total CO_2 (Greenspec, 2015b). And the impacts of the chemical[28] and steel industries were already explained for USA and China.

6. Analysis and Discussion

In this section I will analyse and discuss the empirical results under the scope of the conceptual framework (built in section 2.3). The framework will help explaining how the biophysical trade is interrelated with the socio-environmental impacts presented in the case-studies, and how these elements interplay with Chile's development. The discussion will be presented as separated answers to the research questions, and other important elements worthy to be commented.

As a general aspect, the results corroborate (and update) previous research stating the importance raw materials have in Chilean exports (Meller, 1996, Giljum, 2004). Based on the results and on Chile's background (section 4.), I can affirm that Chile's historical role in the global economy is and has always been to be a supplier of raw materials for other countries (the *centres*). In the background section this condition is reflected in the importance of leather and tallow exportations in the XVIIth century, wheat in the XVIIIth century and natural Sodium Nitrate or "salitre" in the late XIXth and early XXth century. While in the result section the importance of raw materials is obvious considering that iron, wood, salt and copper have represented over 70% of Chile's biophysical

[28] There is an iconic case of pollution related to chemical industry in Japan worthy to comment. The Chisso Minamata factory polluted the ocean with mercury during the 1950s, which was consumed by the people through fish. Thousands died and millions were impacted, thousands with severe diseases, including newborns (EJAtlas, 2015). This case led to reformulate Japan's environmental framework. Nevertheless, as it is an old case, it cannot be included in the EUE analysis.

exports between 1960 and 2014 (Figure 14). Although neoliberalism promoted a diversification in Chile's exportations, this was mainly based in different raw materials (and food products), but not in more complex manufacture products. Thus, neoliberalism has strengthened Chile's role as raw material exported. Furthermore, Chile's principal imports are fossil fuels (energy), followed by intermediate goods (food, fertilizers, pesticides and machines) and final products (manufactures) showing there is a strong connection between exports and imports because several imports are used to produce exports (as energy). Furthermore, Chile's export and import structure has been maintained with few changes since the 1960s, and reflects the country's position as semi-periphery. Following in this section I will discuss these aspects deeper and answer to my research questions.

6.1. EUE as a critique to mainstream trade economic theory

First of all, I will start discussing the relation of EUE with mainstream economic theory. From a mainstream perspective Chile is having an outstanding trade performance. Chile is exploiting and diversifying its competitive advantages in natural resources as Ricardo (1817) suggested; and based on it the country is having since the 1960s an equilibrated trade in monetary terms, even having enormous surpluses in some periods. Thus, from the neoclassical perspective there would be no problems on Chile's trade. However, as shown in the results, despite of this monetary equilibrium Chile has a great material or ecological trade deficit. Therefore the country has an ecologic disequilibrium, originating an ecological debt of the world with Chile. Furthermore, the embodied socio-environmental conflicts I have presented in Chile's exports prove that the country's trade is in fact not that equilibrated as suggested by the mainstream approach. Also, considering that Chile's income gap is increasing over time, i.e. inequalities between Chile and the *centre* are growing (Figure 4), the mainstream promise of catching up with developed countries through exploiting the competitive advantages is not happening for Chile. These three elements (ecological deficit, socio-environmental impacts and widening of income gap) which are considered in the EUE approach but not in the neoclassical one reinforce that EUE is a critique to mainstream theory. These elements demonstrate that the neoclassical monetary approach is too narrow to grasp the deepness of the trade relations in their environmental and social dimensions, and thus it is not enough to explain the consequences of trade (nor at a national or international level). Therefore, as discussed in the framework, EUE can contribute to understand the problems of trade that are invisible for mainstream economics. However, the competitive advantage is still a successful theory in explaining why countries produce what they produce, or how capitalists will take decisions.

6.2. Is Chile having an Ecological Unequal Exchange?

This corresponds to the first research question *(Does Ecological Unequal Exchange occur for the case of Chile?).* Interestingly, the answer will vary depending on which EUE approach is considered. Based on the empirical results of Figure 5**,** Chile is having a permanent and immense material trade deficit with the world. I.e. there is more biophysical material flowing out of the country compared to what is flowing in, generating and ecological deficit (or an ecological debt of the world with Chile). This deficit reflects precisely an asymmetric flow between countries. Therefore, following the traditional and strict definition EUE discussed by authors as Rice (2006, 2007), Roberts and Parks (2009), Andersson and Lindroth (2001), Bringezu and Schutz (2001) or Moran et. al., (2013), the mere fact of the ecological deficit is enough to state Chile is having Ecological Unequal Exchange. Furthermore, the same criteria of ecological deficit can be applied to

the cases of China, USA and Japan. Thus, based on the ecological deficit, Chile would be having Ecological Unequal Exchange relation with those countries (in detriment of Chile).

Nonetheless, based on the conceptual framework and the theoretical critique to the *strict or totalizing* EUE vision presented there, the mere fact of a general ecological deficit is not enough to state EUE relations. Rather, each situation needs to be discussed and analysed deeper, taking into account particularities as the socio-environmental impacts presented in the case studies, and combine them with the biophysical aspects of exchange (in what I called a *relative EUE approach*).

Considering the relative EUE approach, the trade relation with Japan is the only clear case of EUE. Firstly there is a great biophysical deficit. And secondly, after analysing 93% of the trade relation between Chile and Japan (Figure 11), it can be stated that the socio-environmental impacts embodied in Chilean exports to Japan (raw materials) are considerable stronger than those imported from Japan (processed products). Therefore, this trade relation can be considered a clear EUE example. Furthermore, it is worth to note that Chile exports to Japan iron ores, and import back processed steel, machineries and vehicles, thus constituting a classic example of a dependency relationship (unequal exchange), i.e. externalizing the industrial process. This situation reflects a technological dependency, which is considered as one of the mechanisms allowing the existence of unequal exchange (Hornborg, 2014; and Dos Santos, 2015).

The case with USA is very interesting (Figure 9). Despite USA is the biggest economy of the world *(centre)*, Chile only had a small ecological deficit with that country (25.7 million ton), considerably smaller than the one with China and Japan. This is contrary to what could be expected to the relation with the empire and most important centre of XX century. Furthermore, USA exports to Chile mainly very basic products, as fossil fuels and grains, both with a very high socio-environmental impact embodied. USA exports huge impacts from fossil fuel industries and intensive agricultural practices, and Chile also exports huge impacts from mining and forestry industry. Furthermore, maybe Chilean copper workers are better paid and have better working conditions and stronger labour unions than US peasants working in grain monocultures, farmers for Monsanto or oil workers. And maybe the environmental impacts of USA's oil extraction (soil and water pollution, and even increase in earth shaking produced by gas fracking) may even be worse than the ones of Chile's mining exploitation. From a very strict-EUE point of view, regardless the socio-environmental impact, the mere existence of the ecological deficit is enough reason to consider that Chile is having EUE with USA. Nevertheless, considering that USA is also assuming great socio-environmental impacts (the relative EUE approach) the EUE relation with Chile is less clear. This is precisely what was theoretically discussed in the methodological section regarding that it is not possible to weight and compare socio-environmental impacts from different countries in order to state which one is the worst. Rather, both countries are absorbing negative consequences from trade. Therefore, based on the relative-EUE approach, it is not possible to state that Chile is having EUE relations with the USA.

Chile's trade with China is also interesting to be analysed. On one hand Chile has an immense biophysical trade deficit with China (106 million ton: the biggest of the three cases), and therefore from the strict-EUE approach it can be stated that Chile has a EUE with China. However, as shown in the results, China's socio-environmental impacts are so tremendous that probably overwhelm

Chile's impacts. Pollution and social conditions in China are much worse than in Chile, and affects much more people. China's working conditions have elements closer to a modern slavery regime than to a modern economy. Therefore, from the relative-EUE approach it is not clear that Chile is having an EUE relation with China. Here again we find the issue regarding how to measure and compare socio-environmental impacts discussed in the methodological section.

Based on the case of China an USA, and as discussed in the theoretical and methodological section, the strongest limitation to affirm or deny EUE is the fact that the socio-environmental impacts cannot be measured quantitatively nor easily be compared. As explained by Hornborg (2014) as there are several cultural factors involved in the socio-environmental impacts we cannot quantify them. Thus, the comparison of these impacts is very difficult. Therefore, EUE should not focus in how to measure those impacts; rather, they should be taken into account as a quantitative aspect of the trade relation. This situation reflects Dorninger's and Horborg's (2015) discussion with Moran et., al. (2013), regarding the difficulties of testing empirically EUE. From that discussion Dorninger and Hornborg conclude that due to the quantitative limitations it is needed to be very careful with the conclusions regarding EUE. Their conclusions reinforce my point that it is not possible to state clearly that Chile is having EUE with China or with USA.

Considering that the answer to the first research question (is Chile having EUE relations?) depends on the EUE approach (strict or relative), then it becomes essential to analyse "how EUE occurs" (third research question) in order to see which EUE-current is more accurate to explain reality (second research question).

6.3. How does Ecological Unequal Exchange occur?

This corresponds to the third research question. Due to the argumentation line I decided to follow (which I consider the most logical order) I will answer to this research question (the third one) before to the second one that will be answered after this. Furthermore, by answering to *how EUE occurs* I expect to make a contribution to the development of EUE theory.

Recalling the literature review and conceptual framework, EUE is not a unified theory, but I distinguished two different approaches. The strict-EUE approach considered that the world is divided in centres and peripheries connected through EUE relations, where the centres would benefit and develop based on their ecological exploitation of the periphery which would under-develop. I considered that this approach could be found in authors as Rice (2006, 2007), Roberts and Parks (2009) Andersson and Lindroth (2001), Bringezu and Schutz (2001) or Moran et. al., (2013) among others. As discussed in the previous section, the ecological deficit Chile has would be enough reason to state EUE. However, as a critique to this strict-EUE view I presented in the framework what I called as the "relative EUE vision" which includes several critiques to dependency (unequal exchange) and EUE from authors as Cardoso's and Falleto's (1969), Amin (1970), Brenner (1977), Laclau (1977), or Dorninger and Horborg (2015). Instead of making broad and strict generalizations, these authors state it is needed to analyse the particularities and diversities of the trade relations and the world system. These are precisely the aspects I will discuss following, and are directly related to *how EUE occurs*.

6.3.1. Both countries are benefited and impacted at the same time

Based on the results an exceptionally important aspect to be noted is that both trade partners are being benefited and affected by the trade relation at the same time. On the contrary of what the strict-EUE visions state that *the centre would profit at the expense of the periphery externalizing the costs and keeping the benefits,* i.e. the relation would only benefit one part, while worsening the other (idea that is present in several authors as Muradian et al, 2002; Andersson and Lindroth, 2001; Rice, 2007, and Jorgenson, 2011, Fischer-Kowalski and Amann, 2001); what I have showed in the results is that all trade partners (despite they are centre or periphery) are keeping severe socio-environmental impacts but also keeping benefits at the same time. I.e. both are externalizing costs simultaneously, benefiting and worsening of trade simultaneously. The impacts of trade are not flowing unidirectional. From the case studies presented in the results we know that Chile keeps several socio-environmental impacts as water, soil and air pollution, or social struggles against industries affecting peoples' livelihood. But in parallel, the products Chile imports also have severe impacts, as e.g. the consequences of monocultures over soil, fossil fuel exploitation or the horrendous working conditions in some Chinese factories (where even nets have been installed to avoid workers to commit suicide). Therefore, EUE would not occur in the way authors of the strict-current suggest, rather benefits and costs would be distributed in the global economy. I.e. not only the peripheral countries would be assuming the negative impacts, but also the central countries; idea that is closer to the relative-EUE approach presented in the framework. However, this does not imply that both countries share an even amount of impacts, rather the distribution can occur asymmetrically.

6.3.2. World-system roles are not that strict

From the results it is possible to corroborate that the centre-periphery roles are not so strict as "totalizing-dependency" authors or strict-EUE authors suggested. This is precisely the critique several authors had against the totalizing views presented in the framework (Arrighi, 1990; Emmanuel 1969; Brenner, 1977; Laclau, 1977; and Bettelheim, 1972). According to the results, countries would not have "a unique role" as centre or periphery. Rather, these roles would vary inside each country. For example, some sectors of Chile can be considered periphery (as those exporting iron and copper ore), while others can be considered as semi-periphery (as those exporting processed copper or processed wood). Or USA that despites being a traditional *centre* country (the empire), it exports to Chile very basic products as fossil fuels (energy) and grains (food), and thus, in its relation with Chile USA is taking the role of a periphery. Japan does not only export to Chile high technology (as machinery and vehicles) taking a *centre* country role, but it also exports raw materials (as cement and petroleum) adopting a peripheral role. Moreover, as China exports mainly processed and manufactured products to Chile (as steel and toys) it can be considered to have the role of a centre country (or semi-centre), because it exports industrial activity to Chile.

These cases show there is diversity in the centre-periphery relationship. These roles can vary in the trade of different countries (for example Chile-USA and Chile-Japan), and also vary inside each country depending on the economic sector that is analysed (e.g. Chilean ore exports versus processed copper exports). Related to this, Arrighi (1990) points that unequal exchange relations may not coincide with centre-periphery relations. This is also present in the results. The case of USA is very interesting, because despite its trade with Chile is mainly a "peripheral trade" based on

basic products with huge socio-environmental impacts (as fuel and grains), USA cannot be considered to be a peripheral country in the world-system. Or China that despite exporting immense impacts, still has a "higher" position in the global economy that Chile (industrialized, acting as *centre* or *semi-centre*). Thus, the socio-environmental impacts of trade, or a possible EUE, may not coincide with centre-periphery relations. This is coherent with the previous point, which explained that all countries keep negative impacts. Furthermore, following Wallerstein's (1974) and Arrighi (1990) world-system ideas, Chile represents a semi-peripheral country. Chile cannot be considered among the poorest countries, but neither among the richest ones. Furthermore, as shown in the results Chile is also externalizing socio-environmental costs to other countries (as USA and China), thus it can be considered as semi-peripheral.

The main idea of this argumentation is that the centre-periphery categories are not that strict. Rather, they are quite flexible. Therefore, these categories must be handled carefully, and avoid the rigid categorization made by the strict-EUE and strict-dependency theories.

It must be considered that the semi-peripheral category exists (and thus also a semi-centre), that the categories centre-periphery are not strictly related with EUE, and that these roles can change over time (as China that from being periphery industrialized and became centre or semi-centre). These ideas are present in the framework, and are precisely the critiques world-system theories received. However, this does not neglect that a strict EUE centre-periphery relation can exists. E.g. Chile's relation with Japan seems to be close to the strict idea considering that Chile on one hand Chile is having EUE with Japan, and on the other hand there are some elements in the relation reflecting the classical or totalizing-dependency, as the fact that Chile exports iron ore to Japan, and imports back steel products and vehicles made with it; thus, externalizing its industrial and technological process, corresponding to a typical centre-periphery EUE relationship (Dos Santos, 2015).

6.3.3. Development and interdependency

Rice (2007) and Jorgenson (2009) discussed that as the periphery exports its resources its possibilities to use them for its own development are hindered. This would result in stagnation or un-development (corresponding to the strict-EUE vision). However, as shown in the results and already discussed in the previous points, regardless of their peripheral or central role all trade partners are exporting resources. USA exports fossil fuels, China clay and steel and Japan cement. Therefore, the exclusion in the use of resources is mutual, meaning that all countries are losing the possibility to use them. Thus, the link between resource use/exclusion with development/underdevelopment is not that clear.

Furthermore, as benefits are distributed in the world system (and not only concentrated by the *centre*), development can also exist in the periphery. I.e. development can exist despite the centre-periphery roles or the EUE relations. This is precisely was what Cardoso and Falleto (1969) and Arrighi (1990) suggested when analysing the unequal exchange relations. In the results this is reflected in figure (Figure 4) where Chile's income have increased (economic development) despite its peripheral or semi-peripheral condition and despite a possible EUE with the world due to its ecological deficit. Therefore, opposite to the totalizing view of EUE (Rice, 2006, 2006), economic underdevelopment or stagnation would not be a consequence of EUE relations, at least not for the case of Chile. Rather, development can exist under EUE relations. However, it is very important to

note that Figure 4 also shows that, despite Chile has grown, it has grown slower than the centre, thus increasing inequalities. Therefore, it is likely that despite both trade partners can benefit from the relation (grow), one of them can be benefiting more than the other one, and thus growing faster.

Also, as development is not exclusive for the centre but is also present in the periphery, Cardoso's and Falleto's (1969) idea of *interdependency* (later accepted also by Caputo, 2015 and Dos Santos, 2015) makes more sense than the *strict-dependency* visions from the strict EUE approach. Both trade partners depend on each other for their economic process: Chile depends on fossil fuels from USA to fuel its mining industry, as USA depends on Chile's copper and salt; Chile depends on Japans machinery and steel products, as Japan depends on Chile's iron ore to produce those products; and Chile depends on chemicals as fertilizers and pesticides imported from Japan, China and USA to support its forestry industry, just as those countries depends on Chile's wood. Therefore, it is possible to state that EUE relations are *interdependency relations*; which is opposite to the idea that EUE relations are *dependency relations* (inferred from the strict-EUE view).

6.3.4. Class analysis: *who are benefiting and who are worsening?*

Despite all trade partners have benefits and assume costs simultaneously, these impacts are not distributed symmetrically inside the countries. Thus, a key aspect to understand how EUE occurs is to analyse which class or social group inside each country is absorbing most of the benefits and which is assuming most of the costs. This aspect is analogous to the critique presented in the framework from Laclau (1977), Brenner (1977), Cardoso and Falleto (1969) or Arrighi (1990) to totalizing-dependency theory; who suggested that *particularities* must be included in the analysis of trade, as e.g. local historical experiences, power relations, and social struggles. This is also related to Lall's (1975) critique to unequal exchange pointing that even in the rich countries (centre) there is poverty, unemployment, inequality and marginality. I.e. countries are not being benefited/affected as a whole; rather, some groups are benefiting more than others.

In the results the class difference can be seen in several of the case studies. On one hand Chile's forestry industry has contributed to grow immense fortunes as the Matte and Angelini families, which together concentrate 79% of forestry exportations. And on the other hand, the activity is emplaced in the poorest region of the country, with one of the highest unemployment levels and marginality; it faces extremely complicated and violent relations with the Mapuche people who have ancient land claims in the region; and as described by Alarcon (2015), the workers of the industry have had several strikes protesting for their labour regimes.

In the case of the mining industry the class difference is also present, and even more complex. On one hand there are Chilean capitals, international capitals, and also multinational capitals participating in the exploitation. And on the other hand there are mainly small and marginal communities assuming the socio-environmental costs of the activity. In the case studies there are several examples of the class differences. For example the case of PENTA Corporation trying to build La Dominga mine in the small fisher town of Punta de Choros, facing a strong opposition from the community; or the scandalous conflict of Pelambres mine owned by Luksic group (one of the richest of the country) against the agricultural community of Caimanes, due to the tailing dam polluted their water sources. Also, in the results several cases of water and soil pollution affecting small communities were presented, as well as cases where tailing dams has broken producing health

hazards (and even burying El Cobre town with its more than two hundred habitants in 1965). Labour relations are also problematic in the mining industry. Despite workers for the big mining industry enjoy high salaries, as presented in the results there are several external workers without the same benefits; and working conditions worsens considering smaller companies. In this regard it is relevant to remember the case of the 33 mining workers who were trapped underground for 69 days after their mine collapsed. This class argument is strengthened considering that, as presented in the results, there are more than 60 mining projects and indirectly related with mining (as energetic projects to supply mines) stagnated in courts due to legal prosecutions mainly done by indigenous groups and rural communities. Furthermore, as explained in the results, Chile has witnessed massive protests against these kinds of projects; as e.g. against Barrick Gold's Pascualama mine, HydroAysen project in the Patagonia or Barrancones thermoelectric project in Punta de Choros. This evidence there is a part of Chile's population that do not feel benefited by these projects.

Therefore, the class-analysis regarding Chile's trade is very clear: there is a group benefiting a lot, while other groups are assuming the costs. The groups assuming the costs are principally indigenous people, peasant communities and workers, receiving the impacts from mines and forestry; while the benefited ones are Chile's elite or oligarchy (e.g. some of the richest families of the country). There are also several multinational corporations involved, especially in the mining sector, proving that capital does not have nationality.

However, a situation that complicates the class analysis is to taking into account that Chile's State is also a producer/exporter. E.g. Chile's State owns the biggest copper company in the world (CODELCO). As shown in the results, CODELCO is also responsible for socio-environmental impacts, as the pollution in Ventanas town affecting the health and livelihood of the population (town considered as a "sacrifice zone" by the State). This represents a new difficulty that should be included in future EUE analysis, because with the income of CODELCO the State pays several public goods for the country (as health and education), complicating the analysis of which group is benefiting from the copper extraction.

Nonetheless, despite the possibility of having a State as producer, based on my analysis I can state that EUE occurs under a clear class structure: elite classes benefiting in detriment of poor classes, and at an international level. This is closely related to what Cardoso and Falleto (1969) described as *associated dependent development,* where the peripheral elites, in association with central elites, also accessed the benefits of trade. Idea that is also connected with the points 6.3.1., and 6.3.3.

6.3.5. There is a "Chain effect"

An interesting aspect regarding *how EUE occurs* is what I refer to as the chain-effect in trade in the framework, discussed by Dorninger and Horborg (2015). As shown in the case studies many products are imported by Chile to use them to produce exports. E.g. Chile imports energy from USA (fossil fuel) which is later used in the mining industry to produce for example copper and iron, which later are exported. Or the fertilizers Chile imports from USA, China and Japan, are used in Chile's forestry industry, to grow the forests which later will be exported to the same countries. Or Chilean iron which is exported to Japan, and maybe used to produce the vehicles which are later imported back by Chile. And the technology as machineries and vehicles Chile imports from Japan may also be used to produce products that will be exported.

The global economy is extremely interconnected (reinforcing the idea of *interdependency* between countries), thus it becomes very difficult to separate the production processes between countries. Not all the inputs used in Chile's mining or forestry industry are created in Chile. This constitutes a difficulty to EUE analysis in the sense on how to distribute the socio-environmental impacts in an interconnected production process with several inputs coming from different countries. For example, should the impacts of USA's fossil fuel extraction be accounted to Chile if they are used to produce products that will be exported to USA? Or if Chile is importing back the iron in form of vehicles, machinery and steel, should the impacts of iron production be accounted to EUE as Chile is still benefiting from it? This makes even more difficult to measure EUE, reinforcing the discussion of Dorninger and Horborg (2015) in regard to the need of being more careful with conclusions on EUE studies.

6.4. How does Ecological Unequal Exchange interplay with development?

The third research question is related to how EUE occurs, which was already answered, but also with *how EUE can affect or be connected with the economic development of a country.* This is a very important issue to understand the consequences EUE has. In the literature review it was explained that the strict-EUE current considered that the country benefited from EUE (the centre) would develop at the expense of the country that is disadvantaged by it (periphery) which would under-develop or be stagnated. Nonetheless, in section 6.3.1., 6.3.3., and 6.3.4., I showed that both countries are being benefited and impacted simultaneously, that both can grow and that there are some groups in each country benefiting more than others. Therefore, the relation strict-EUE described between EUE and development seems not to be occurring in reality, at least not for the case of Chile, and thus this relations need to be discussed deeper.

6.4.1. EUE transforms local groups and their socio-economic structures

Based on the conceptual framework and on the results, I have one idea that could answer to how EUE is linked with development. The key to understand the relation between EUE and development is to analyse how the social groups taking part of it are being impacted and transformed by EUE. I.e. the key would be to analyse *the local effects of the global interaction*. I consider that this was precisely Bunker's (1984) approach when analysing how the groups in the Amazons were impacted by EUE. And it is closely connected to Cardoso's and Falleto's (1969), Brenner's (1977) and Laclau's (1977) critique to unequal exchange, regarding the needed to analyse the particularities of the trade relations, because the economies can be very diverse.

As explained in the results EUE, through disturbing the ecosystems, is transforming the local economies and their social relations. I.e. EUE transforms the way some groups live. Depending on how those local groups adapt to this transformation, the result can be *development* or *under-development* for them. If they have a positive adaptation to the new context, they may develop. But if they have a negative adaptation, they may under-develop, and increase their poverty and marginality. Thus, the key to understand how EUE interplays with development is to analyse how EUE transforms the local contexts, its economy and society.

In the case studies presented in the results there are several examples of how trade transforms the local realities. Pelambres mine, through polluting the water sources of Caimanes agricultural community is stressing their local economy and therefore transforming the way they make their

living. Similar conclusions can be inferred from Pascualama mine affecting the water sources of the Aymara communities. Furthermore, CELCO pulp mill through polluting Laraquete bay impacts the artisanal fishers' economy, as explained in the results there have been cases of massive fish death. This cuts the income source of the fishers living in the area. CODELCO's plant in Ventanas town also polluted the ocean where artisanal fisher groups used to work on. The forestry industry through its intensive water use stresses the economy of small agricultural agents in the region. These are also examples on how global trade pushes to transform local economies.

For the case of forestry Alarcón (2015) also discusses a proletarianization process: how traditional peasants became forestry workers, and how small farmers became forestry peasants. Since there are not many work sources in the region (which in fact has one of the highest unemployment levels of the country) and since the forestry's ecological impact affects local agricultural activities, it could be difficult to oppose to this proletarianization. Isakson (2015) describes a similar phenomenon but for the artisanal fishing sector: the overexploitation of the ocean (mainly to export fish resources: EUE) transformed artisanal fishers economic practices, increased their poverty and made several fishers migrate from their towns, losing their traditional activity and cultural practices. Both are examples on how EUE transforms local ecologies, economies and social relations. Therefore, as exports increases, the pressure on them also increases.

From the historical background there also are several interesting examples. In the XVIIIth century Chile's small cattle farms (the main economic unit during the XVIIth century) were transformed into big haciendas (main economic unit of the XVIIIth century) in order to export grains to Peru. On one hand the creation of haciendas changed the use of nature, and on the other it led to the formation of a massive peasant class (ecological and social transformation). During the XIXth century part of that peasant working class was moved to the dessert to work in the mines producing *salitre* to be exported to Europe. This peasant class was transformed into a mining industrial working class, and was subject to one of the worst exploitation regimes in the history of the country (social transformation). When *salitre* production collapsed in the XXth century, the mass of workers had to migrate to cities generating deep poverty and one of Chile's worse social crises (social transformation). This suggests that historically, hand by hand with exportations and EUE society, nature and the local economies have been transformed.

It is important to note that all the examples presented show how EUE represses local societies and its productive forces. Nevertheless, the consequences of these transformations are not necessarily negative, but can also be positive. For example Greco (2015) discussed a positive experience from the overfishing crisis in Punta de Choros town, which led the community to organize Management Areas (or "aquatic farms"), achieving a sustainable production and avoiding overexploitation. The Management Areas permitted fishers to generate an income when there were no resources in the ocean, preventing migrations that could have led to the disappearance of the small fishing town. Over time, fishers invested in a processing plant to add value to their catch, and invested the income in their town building a school and a communitarian house. This reflects a successful adaptation to EUE, which in fact leads to development. And furthermore, this case demonstrates that the link of EUE with development is not necessarily negative, i.e. EUE does not produce necessarily under-development for the group affected by it.

EUE can have different effects on society, and the way local groups are transformed by the EUE is very diverse. If the groups are innovative, have what Arrighi (1990) called *creative-destruction* (based on Schumpeter's ideas), they can actually develop economically, as Punta de Choros did. Otherwise, they will just suffer the negative impacts of EUE. This is precisely what I consider the most relevant aspect to understand EUE: *to put attention on the particularities, on the local transformation EUE triggers*, because this is precisely the direct connection between EUE and economic development. Therefore, to answering to how EUE interplays with development: *both economic development and underdevelopment can occur under EUE relations depending on how the local realities are transformed and how the local groups adapt to those transformations*. Thus, depending on this transformation and adaptation process, inequalities between countries (the income gap) can widen or shorten. A topic that remains for future studies is how EUE affects the wealthy groups (which are benefited from it), and how they are transformed by trade.

6.4.2. The transformation of the State

Furthermore, EUE does not only transform social groups, but into some extent also transforms the institutions. As I will show there is a tendency of the institutions to secure the functioning of the trade economy. I.e. the State institutions play a major role in EUE. In some cases the State can take over the exportation economy and become directly a producer, which is the case of Chile's State Copper Company (CODELCO). However, in most of the cases the State has the role of potentiating and securing the groups benefiting from trade. Brenner (1977) discussed the State would also be transformed to secure the functioning of the unequal exchange, thus acting as a class-mechanism.

In the results the role of the State to maintain the status-quo of a small elite benefiting from trade is evident. For example the deep transformation of Chile's state into a neoliberal State, privatizing its national resources (which is the basis for their commoditization) opening the country to the global economy (Chile has free trade agreements with over 60 nations) and reducing labour protections and welfare, facilitated the exploitation of raw materials and its international trade. Also, related to the case studies the role of the State is evidenced in several cases. For example the forestry subsidy which promotes the industry to develop despite its negative consequences over local communities and nature. The militarization of the forestry region (Araucania) is also an example, where the State has displaced its repressive power to struggle against Mapuche's people land claims and protests against the forestry industry. Or the ideas of some politicians to limit the ILO 169 Convention, in order to weaken the legal power of indigenous groups to avoid the legal procession of mining projects: i.e. trying to weak the poor and the marginal groups of society, to secure the power of the wealthy and powerful.

Furthermore, there have been several corruption cases of the State, showing its close relations with the country's elite. PENTA and SQM corporations, both related to mining industry, financed illegally politicians and parliamentarians (despite right or left wing). Angelini's company CORPESCA related to the fishing activity had the same modus operandi. This reflects the strong links some powerful corporations have with the State, going far beyond "normal lobby". And maybe due to those connections the scandalous case of Pelambres mines could be explained. In the sense that despite a rule from Chile's Supreme Court of Justice ordering to close and move Pelambre's tailing dam due to its impact over Caimanes community, the situation has still not be solved after almost one year from the legal decision. In this case the State, instead of enforcing the

legal decision of the Supreme Court, has repressed the protests of Caimanes community with anti-riot police force. Either the mine is over the law, or the State is subordinated to the mine.

Thus, the State adapts to the situation to becoming a facilitator of EUE. This is precisely what Arrighi (1990) discussed over the authoritarian regimes in Latin America, and how they protect the oligarchic wealth, with the difference Chile is not an authoritarian dictatorship, but a neoliberal "democracy". However, it seems that the neoliberal State acts with the same logic of an authoritarian regime in protecting the wealthy groups in detriment of the poor groups.

6.5. How accurate is EUE to explain the consequences of trade?

Finally, this section corresponds to the second research question *(How accurate is Ecological Unequal Exchange Theory to explain the transfer of socio-environmental impacts between countries and its consequences?)*. Interestingly, there is no one absolute answer, because as discussed EUE is not a unified theory. I have distinguished two main currents: *strict-EUE* and *relative-EUE* (or critical or non-strict). Thus, the answer to the question depends on which of these currents is chosen to analyse trade.

By building the critical framework, and later applying it to analysing Chile's exchange, I have indirectly constructed a critique to strict-EUE theory. As discussed, EUE would not occur as the strict-current suggests, neither its relation with development would be as the strict-current suggests. Therefore, strict-EUE seems not to be accurate enough to explain trade and its consequences. Furthermore, the relative-EUE approach, as presented in the framework, is based on a critical analysis on EUE and incorporates the criticisms dependency and "classical" unequal exchange had from several authors. As explained, these criticisms were mainly from the social sciences with strong influence of the Marxist tradition; as e.g. the idea that all countries assume costs of trade, the need of making a class analysis and analyse particularities, that the world-system roles are flexible or the idea that both trade partners (despite being centre or periphery) can develop from the trade relation. As demonstrated along the discussion, by including these critiques to EUE theory, the theory becomes much more accurate to explain the complex issues involved in trade relations, with its social and ecologic dimension. Therefore, I consider that the critical/relative-EUE approach is more accurate to explain trade as opposed to the strict-EUE approach.

7. Conclusions

This thesis has presented a critical analysis of Ecological Unequal Exchange theory (EUE). Through a deep theoretical discussion, and applying it to a detailed empirical case study on Chile's trade, this thesis has criticised what I called as the *strict-EUE approach* highlighting its limitations to explain trade and is consequences. Based on this analysis, this thesis has argued for a *critical* or *relative-EUE approach*. Furthermore, the theoretical and empirical conclusions of this study can help understanding how Chile is inserted in the world economy, and what consequences international trade have in the country.

Based on this study several conclusions can be done regarding *if Chile is having EUE, how EUE occurs, what consequences it has on the development of the country,* and also, *regarding how*

accurate EUE theory is to understand Chile's trade context. I will proceed to list the principal conclusions.

1. This thesis reinforces EUE as a strong critique to mainstream economic trade theories (competitive advantages). From the competitive advantages theory perspective, Chile is having an outstanding trade performance: diversifying its exports and having and equilibrated monetary balance (with huge surpluses in some periods). Nevertheless, the EUE analysis showed Chile is having a great ecological deficit and that there are several socio-environmental costs being absorbed by the country that are not being considered in the mainstream approach. Furthermore, as Chile's income gap has widened since the 1960, the neoliberal promises of developing the country and catching up with the rich nations based on free trade, is –at the moment- false. Therefore, this thesis has challenged Chile's trade performance, emphasising EUE as a strong critique to the neoclassical (mainstream) approach to trade and its limitations to understand the social and environmental dimensions of international exchange.

2. Regarding *if Chile is having EUE*, the answer will depend on which approach of EUE is taken. Following what I referred to as the strict-EUE approach, the fact that Chile is having an immense ecological deficit (meaning that there is more nature or biophysical material being exported than what is being imported), would imply Chile is having EUE. Nonetheless, this thesis concludes that the ecological deficit criterion is not enough to state EUE, but the social dimension related to trade (as social impacts) must be considered, in what I called the *critical* or *relative-EUE* approach. This constitutes a critique to the strict-EUE's focus on trying to measure quantitatively the amount of nature being traded between countries, stating that such thing is hardly realistic and misses the importance of the social aspects. Furthermore, based on this relative-EUE approach, it is not clear that Chile is having EUE relations. There are several particularities of each ecosystem and social systems (as cultural aspects) that make the socio-environmental impacts non-quantifiable. Therefore, their measurement or comparison to decide which country has worse socio-environmental impacts, and thus which country is being most affected by trade, is very subjective. Thus, based on the relative-EUE approach, it is not possible to affirm (or neglect) that Chile is having Ecological Unequal Exchange relations.

2. Regarding *how EUE occurs*, the results showed that all trade partners, despite their role as *centre* or *periphery*, are exporting and importing a wide sort of socio-environmental impacts. I.e. all countries are having costs to produce their exports, but at the same time all countries are also benefiting by the trade relations. This is opposite to the strict-EUE vision of some authors that considers that the *centre countries* would exclusively benefit of trade at the expense of *peripheral countries, which would be assuming the costs of centre's benefits*.

4. As benefits are distributed economic development can also exist in the *periphery,* even under EUE relations. I.e. the periphery can develop despite having EUE relations. This conclusion is also opposite to the strict EUE-view which considers that only the centres would develop from the trade relations, while the periphery would under-develop or be stagnated. Therefore, strict-EUE falls short in explaining the relation between EUE and development.

5. This thesis has shown that the production of Chile's main exportation products is strongly interconnected with the importations of other countries. E.g. mining industry needs the imports of

fossil fuels; and forestry industry needs the imports of fertilizers, pesticides or technology. This situation suggests that Chile is having *dependency relations* with its trade partners *(centres)*. Nonetheless, the results also showed that those trade partners *(centres)* also need Chile's iron, copper and wood. Therefore, this thesis concludes that the relations of Chile are not of *dependency*, but are *interdependency-relations.*

6. Furthermore, this thesis concludes that, despite being *centre* or *periphery*, EUE do not produce *dependency* relations at all. Rather, EUE produces *interdependency relations*. Countries are closely interconnected in the global economy, and all depends on the exports and imports of other countries. Therefore, strict-dependency, although it can exist, would not be a common relationship. This idea is reinforced by the analysis of the diversity in the world-system roles (centre, semi-centre, semi-periphery and periphery). Regarding these world-system positions, this thesis concludes Chile has a *semi-peripheral* role (benefiting but also being affected by trade).

7. Regarding *how EUE occurs*, this thesis concludes that the socio-environmental impacts of EUE are not equally distributed inside the countries, but there are some social groups or classes benefiting from trade while other groups are assuming its negative consequences. In the case of Chile the affected groups coincide with poor and marginal sectors from society, as indigenous and agricultural communities; while the benefited groups are part of Chile's elite, as capital owners or oligarchy. Therefore, this thesis concludes that EUE occurs based on class structures at an international level, idea that is opposite to the Strict-EUE visions which consider EUE occurs at a country-base level (centre-periphery world-division).

8. Regarding how *EUE interplays with development*, this thesis has made a strong critique to Strict-EUE. The strict approach suggests *centres* will develop from EUE while *peripheries* would under-develop. However, this study has deepens in how EUE interplays with development, showing that the relation is not that rigid or deterministic. When transforming the local ecosystems, EUE is as well transforming the socio-economic relations of the groups connected to it (as agricultural, indigenous or fisher communities). Based on this situation, this thesis concludes that depending on how those groups adapt to the new ecological, social and economic context produced by EUE, those groups can develop or un-develop. A successful adaptation could produce development, while and unsuccessful adaptation would lead to increasing poverty and marginality. Furthermore, analysing these kind of dynamics, i.e. *how the global processes affect the local realities*, is the very key to understand how Ecological Unequal Exchange occurs, and how it is connected with the economic development experience of different countries in different particular contexts.

9. This thesis has discussed that as trade becomes deeper, the State and its institutions are also pushed to change and adapt to the EUE relations. The State acts as mechanism to secure the Ecological Unequal Exchange, in favour of the benefited groups and in detriment of the impacted ones. As showed in the results, this operation is cryptically influenced by the benefited groups (the elite) through corruption with different levels of politicians and parliamentarians, materialized in favourable laws and protection to their interests; situation that has become stronger under Chile's neoliberal model.

10. Finally, from an historical perspective, this thesis suggests that since the XVIIth century Chile may have been subjected to Ecological Unequal Exchange, showing how its trade have impacted

nature and transformed the social and productive relations in the country. Furthermore, the impacts of international trade in the country have become stronger under the development of the neoliberal model in the country, mainly because trade has intensively expanded.

Therefore, through criticizing the *strict-EUE approach* several authors had, this thesis has aimed to contribute to the deepening of the EUE theory. The *strict-approach* is presented as an attempt of constructing an empirically testable qualitative theory, focused on measuring asymmetrical transfers of biophysical values between countries. As shown, EUE would not occur as the strict approach suggests, neither it have its presumed consequences over development. However, this thesis has promoted a *critical* or *relative-EUE approach*, emphasizing the importance of the social analysis, and considering EUE as a *qualitative concept to understand how international trade relations with embodied socio-environmental impact, under asymmetrical power relations, transform local realities, and thereby impact the development of a country*. I.e. how the global processes affect and transform the local realities. Furthermore, this critique to Ecological Unequal Exchange reflects that economics, environment and society are tied together and cannot be separated, but must be analysed together. Thus, trade and EUE relations are Political Ecology relations. As final words, I consider this thesis demonstrates the *critical* or *relative* approach to EUE is more accurate to understand the complexities of trade, and thereby to help promoting a Sustainable Development.

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Appendix

1. Monetary Balance of Trade

The Monetary Balance of Trade is the account used traditionally by mainstream economists to analyse trade[29]. It shows if a country has a monetary surplus or a deficit (debt) with the rest of the world. Figure 12 shows Chile's monetary balance of trade with the world since 1962 (in thousands current US$). Generally it has been equilibrated, I.e. the country's income was very similar to its expenditure; and thus no big deficit is present. Nevertheless, since the early 2000s an enormous surplus can be seen. This is principally to the high copper price, which implied vast income to the country reaching over 20 billion US$. A surplus in the balance of trade would suggest the country is benefiting in monetary terms from its trade.

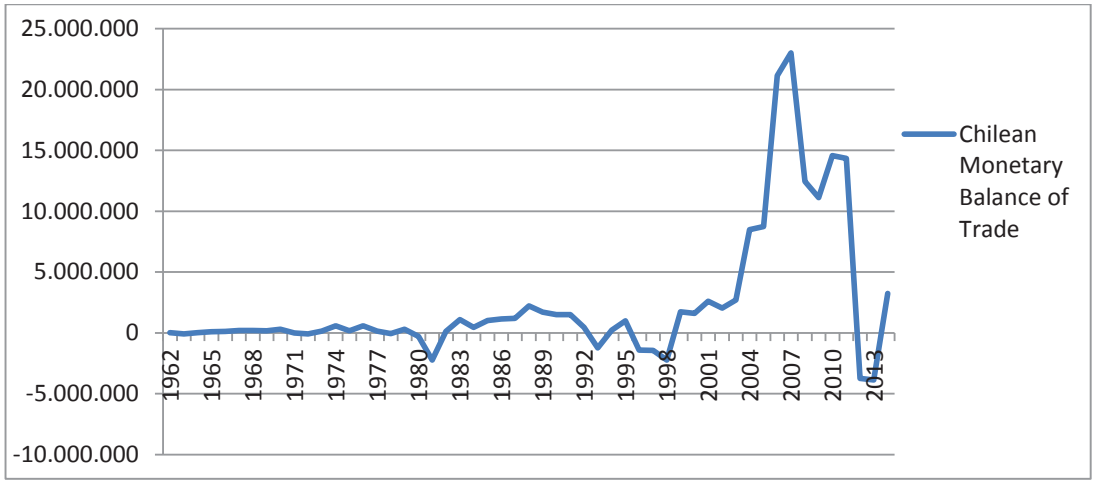

Figure 12: Chilean Monetary Balance of Trade, in thousand current US Dollars. *Source: Own Creation based on data from ECLA-badecel and UN-comtrade databases.*

[29] It is calculated through the form [Exports ($) - Imports ($)].

2. Chilean four main export products in Monetary terms

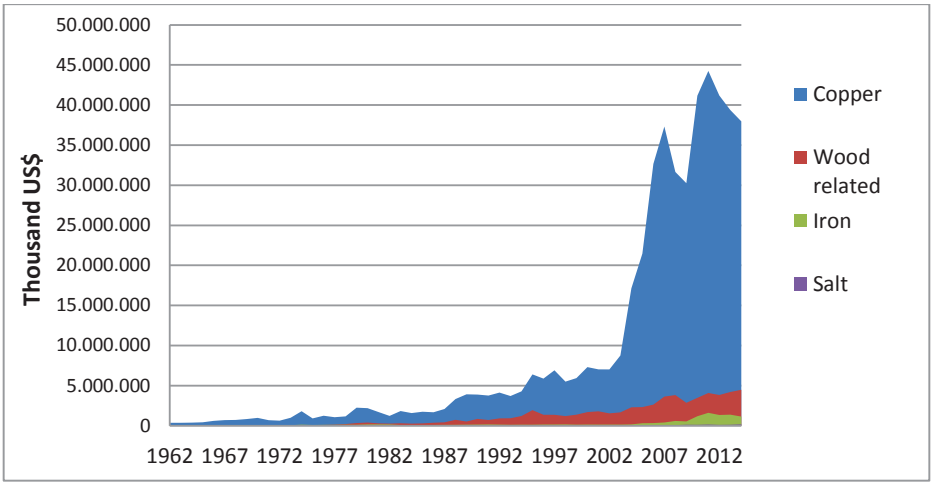

Figure 13: Chilean exports of Copper, Wood related, Iron and Salt products (in thousand current US$) between 1962 and 2014. *Source: Own Creation based on calculations with data from ECLA-badecel and UN-comtrade databases.*

3. The share of Chile's main four exportation products

Iron, Copper, Wood and Salt were until late 1970s more than 80% of Chile's total exports. Since the 1980s their share decreased (but never falling under 50%), reflecting that the country have slightly been diversifying its exports (principally in food products). Nevertheless, since 2007, their share increased again and in 2014 they represented 73% of Chilean total material exports and 58% of the country's total income of exports.

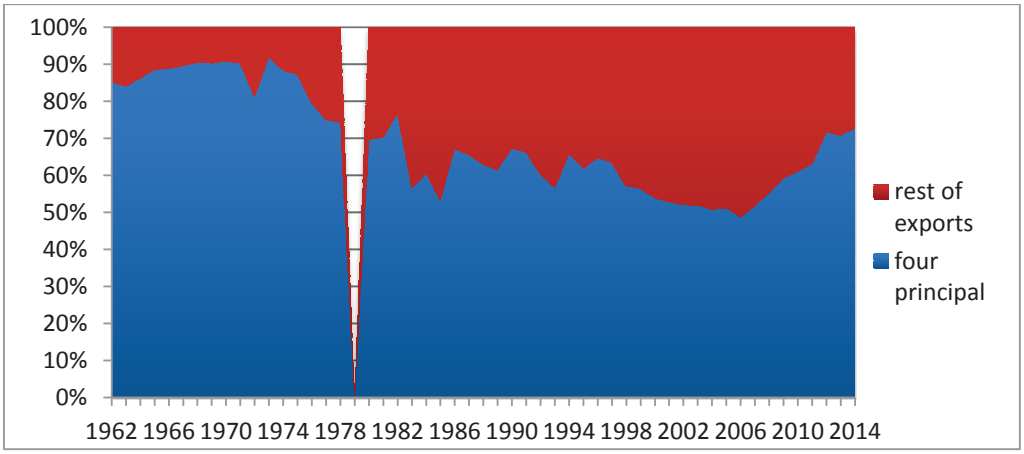

Figure 14: Chiles' four main export products versus the rest of the country's exports; in biophysical terms (tons) between 1962 and 2014. *Source: Own Creation based on calculations with data from ECLA-badecel and UN-comtrade databases.*

4. Copper

Chile is one of the world's biggest copper producers, and the first copper exporter[30]. Almost all the copper produced in the country is for exportation. Between 1985 and 2014, approximately 98.2% of

[30] Chile is the 1st world exporter of processed copper, and the 2nd regarding concentrated copper (after Peru). Summing both, Chile is the major copper exporter of the world.

copper Chile's production has been exported (own calculations)[31]. Thus, its socio-environmental impacts are being externalized from other countries (relevant for EUE). In 2014 Copper represented 10.2% of Chile's physical exports (5.7 million tonnes), and 50.2% of the total income from exports.

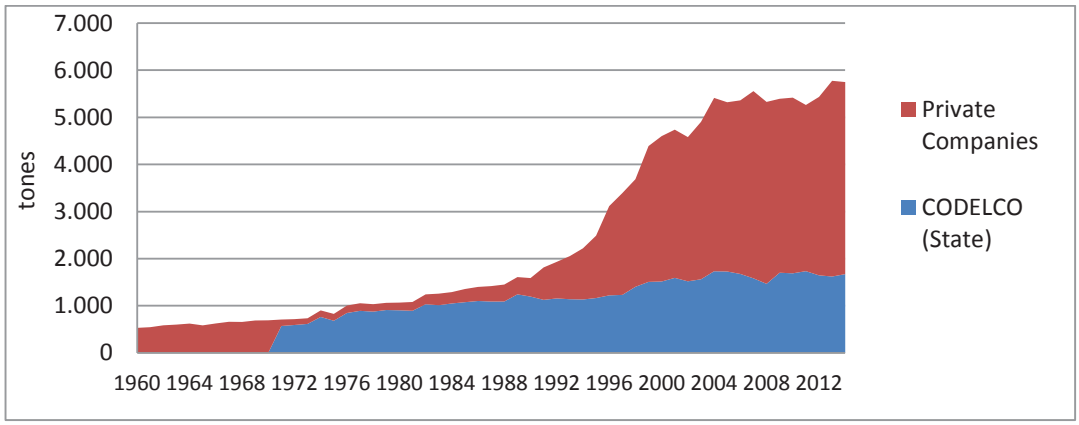

Figure 15: Chilean Public and Private Copper production (fine content) in thousand tons, since 1960 to 2014. *Source: Own Creation based on statistics from Meller (2000) and COCHILCO database.*

Copper is produced by the State (CODELCO) and by private companies. Both produce two main copper products: Copper Concentrates (ores, rocks) and "Manufactured Copper" (Refined and Blister)[32]. Figure 15 shows how the total production has evolved. It is possible to see the effects of Chile's Copper Nationalization in the year 1971 (Allende's government). Private production has increased strongly since the 1990s, becoming considerable bigger than CODELCO (2.4 times bigger in 2014), reflecting the dispossession of Chilean natural resources under the neoliberal model. These elements are relevant to be considered in the EUE analysis.

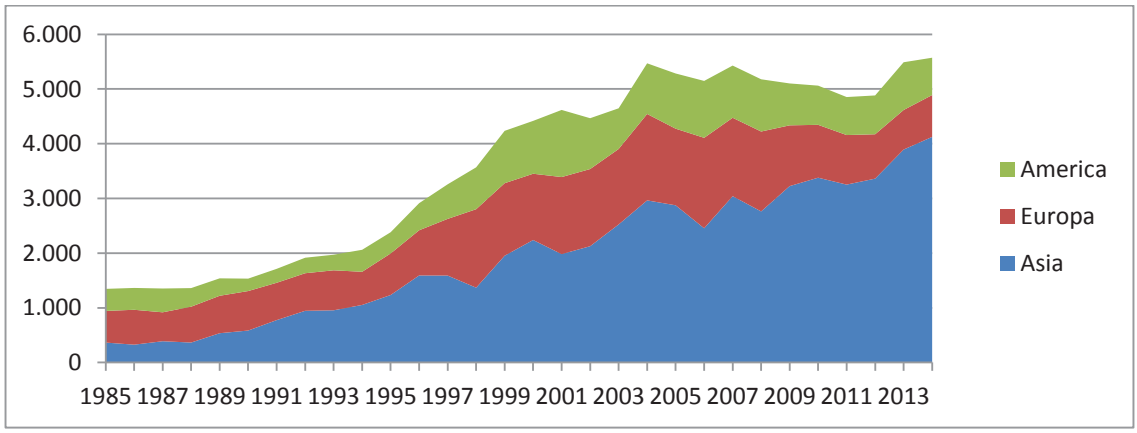

Figure 16: Principal areas where Chilean Copper (concentrated and processed) is being exported (in thousand tonnes). *Source: Own Creation based on statistics from ECLA-badecel database.*

[31] Own calculation based on COCHILCO data, comparing Chile's yearly copper production *(metric tons of copper content)* with the yearly exports *(*also *metric tons of copper content)*.

[32] Copper concentrates are represented by Category 2831 *(Ores and concentrates of copper, incl. Matte)* of the SITC-Rev.1; And Processed copper is represented by Categories 68211 *(Blister copper and other unrefined copper)* and 68212 *(Refined copper including remelted)*.

For the EUE analysis, a major concern is to analyse *where* Chile's copper have been and is being exported to, which we can see in Figure 16.

Since the 1980s it is possible to see a constant increase of Asia as the main destination of Chilean copper products (in tonnes), displacing totally the Americas and Europe. For the EUE we need to know to which country (not area) copper is flowing. Thus, I will analyse the two copper products separately (processed and concentrate/ore).

Processed Copper (SICT Rev.1- 6821)						
Country	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2010-2014**
USA	32%	11%	22%	13%	13%	11%
China	0%	2%	2%	3%	14%	40%
Japan	3%	10%	6%	11%	2%	1%
India	0%	0%	0%	1%	0%	0%
Rep. Of Korea	0%	1%	1%	9%	8%	8%
Brazil	2%	7%	9%	4%	4%	6%
Germany	10%	15%	11%	6%	2%	0%
France	5%	5%	7%	8%	9%	3%
UK	18%	12%	8%	12%	4%	0%
Italy	7%	9%	11%	8%	12%	6%
Netherlands	12%	7%	3%	1%	5%	5%
Other Countries	11%	20%	21%	24%	25%	20%
Total (ton)	**4551183**	**5.775.594**	**8.295.011**	**11.020.947**	**24.407.692**	**16.528.203**

Table 3: Main destination of Chile's "processed" copper production. *Source: Own Creation based on SICT Rev.1 – 6821 statistics from UN-Comtrade, ECLA-Badecel databases and compared with COCHILCO data. Data for the 1960s is only available since 1962, and data for 1979 is not available.*

Until the 1990s USA was Chile's biggest importer of processed (Refined and Blister) copper products, followed closely by European countries (U.K, Germany, Italy, France and Netherlands). Japan was also an important destination from the 1970s to the 1990s. Nevertheless, since the 2000s Asia has become the main importer of Chilean processed copper, displacing completely Europe and USA. China, between 2010 and 2014, has received 40% of Chile's processed copper exports, being the main importer at the present.

Concentrated Copper (SITC Rev.1- 2831)						
Country	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2010-2014**
USA	1%	0%	10%	3%	2%	0%
China	0%	0%	2%	7%	18%	30%
Japan	43%	31%	32%	44%	33%	30%
India	0%	0%	0%	1%	9%	13%
Rep. Of Korea	0%	5%	8%	6%	9%	8%
Brazil	0%	0%	18%	11%	8%	5%
Germany	46%	30%	4%	12%	8%	3%
Spain	3%	3%	7%	9%	4%	4%

Other Countries	8%	30%	19%	7%	10%	6%
Total (ton)	**406.683**	**1.671.473**	**6.323.724**	**8.000.946**	**18.646.306**	**11.032.847**

Table 4: Main destinations of Chilean "concentrated" copper production. *Source: Own Creation based on SICT Rev.1 – 6821 statistics from UN-Comtrade, ECLA-Badecel databases and compared with COCHILCO data. Data for the 1960s is only available since 1962, and data for 1979 is not available.*

In the 1960s, Germany and Japan were the main buyers of Chilean concentrated copper (to be refined and processed). Japan has maintained and important share, and is Chile's historical biggest buyer of this product. Nevertheless Germany lost progressively importance, while China started acquiring a major share. Brazil, Rep. of Korea and India are also important buyers.

According to this information a tendency can be seen that the main destination of Chilean copper have moved from Western to Eastern. Western Countries (USA and Europe) still buys an important share of processed copper products, but almost no *raw copper*; while Eastern countries have increased enormously their share of raw and processed copper. This could be related to a western tendency of moving their industrial process to Asia, which has passed through a fast industrial revolution. Thus, Chile's *centre* regarding copper has moved to the East.

5. Iron Ore

In biophysical terms iron is Chile's major mining product (Figure 2) and also its major export product (Figure 17). Chile is the 9th world's iron exporter. Between 1962 and 2014, 77% of Chile's iron production was exported (376.5 million tonnes); while in 2014 iron represented 25% of Chile's total material exports (14.1 million tonnes). As the country is not industrialized, national production is enough to supply local industries and export the surplus. Despite being the country's major material export, in monetary terms it only contributed with 1.5% of the income from exports (2014).

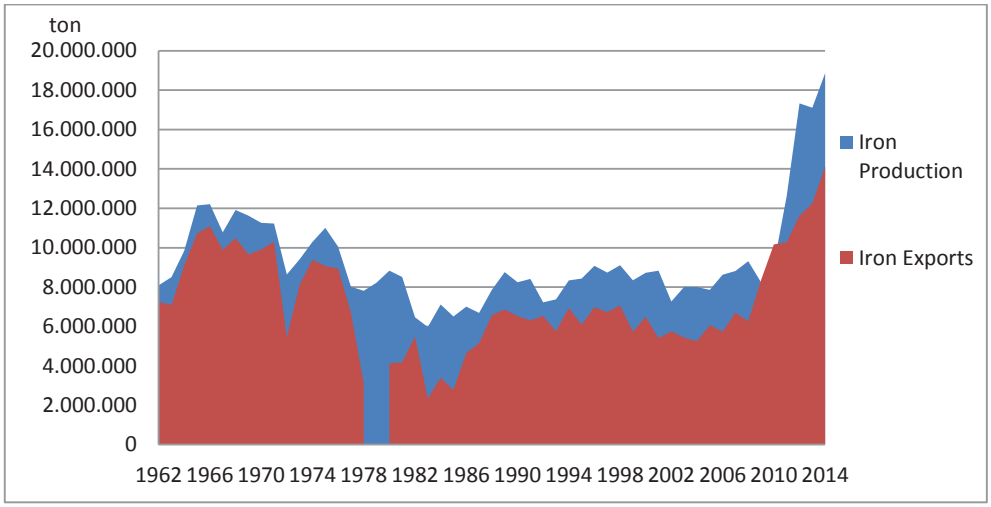

Figure 17: Chilean Iron production and exoprts (in tonnes) between 1962 and 2014. *Source: Own Creation based on data from Catholic University historical data, COCHILCO databases and yearbooks, and SONAMINERA Mining Bulletins for iron production; and exports from UN-Comtrade, SICT Rev.1 – 2813. No export data available for 1979.*

The main destinations of Chilean iron exports vary over time and can be seen in Table 5.

Iron Ore and Concentrates (SICT Rev.1- 2813)						
Country	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2010-2014**
USA	24%	7%	3%	2%	5%	1%
Japan	68%	80%	88%	51%	28%	10%
China	0%	0%	0%	2%	35%	78%
Rep. Of Korea	0%	0%	0%	20%	10%	0%
Germany	0%	0%	4%	11%	0%	0%
Other Countries	8%	13%	5%	14%	22%	11%
Total (ton)	**75.320.972**	**71.024.996**	**45.573.527**	**64.680.352**	**61.481.218**	**58.452.253**

Table 5: Main destinations of Chilean iron ore and concentrates. *Source: Own Creation based on SICT Rev.1 – 6821 statistics from UN-Comtrade, ECLA-Badecel databases and compared with COCHILCO data. Data for the 1960s is only available since 1962, and data for 1979 is not available.*

From the 1960s and until the 1990s Japan was Chile's major iron importer. USA was important during the 1960s, but then its share decreased progressively. At the present China is Chile's biggest iron buyer, concentrating 78% of its exports between 2010 and 2014. In the case of Iron, the "centre" has always been in Asia, only moved from Japan to China.

6. Salt

Chilean salt production is private[33]. Salt is extracted in northern Chile from the Atacama Salt Lake in an open pit mine. Interestingly, a part of the salt lake is a National Reserve[34]. In 2014 Chile was the 1st world exporter of salt with 9.9 million tonnes, representing 17.6% of Chile's total material exports (the country's third export product). Nevertheless, in monetary terms it only represents 0.2% of the income from exports (173.9 million US$ in 2014). Table 6 shows the main destinations of Chilean Salt since 1960s.

Salt (SICT Rev.1 - 2763)						
Country	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2010-2014**
USA	**45%**	**83%**	**68%**	**77%**	**67%**	**68%**
Canada	**0%**	**0%**	**11%**	**4%**	**2%**	**3%**
Brazil	**1%**	**0%**	**14%**	**5%**	**8%**	**14%**
Japan	**54%**	**7%**	**0%**	**9%**	**1%**	**0%**
Other Countries	**0%**	**10%**	**7%**	**5%**	**21%**	**14%**
Total (ton)	**1.917.352**	**1.636.752**	**5.096.626**	**18.957.187**	**42.049.999**	**38.211.359**

Table 6: Chilean salt exports by country. *Source: Own Creation based on SICT Rev.1 – 6821 statistics from UN-Comtrade, ECLA-Badecel databases and compared with COCHILCO data. Data for the 1960s is only available since 1962, and data for 1979 is not available.*

[33] The biggest company is "Sociedad Punta de Lobos" (Sal Lobos), founded in 1905.
[34] The amount of salt is considered to be so vast that it could supply the whole humanity for 5 thousand years (SALLOBOS, 2015).

USA is historically Chile's main salt importer. Japan was important during the 1960s, but decreased progressively until the present, and since 2010 Brazil has increased its imports of Chilean salt.

7. Wood Related Products

Wood related products are in biophysical terms Chile's second biggest export (Figure 18). The four most important wood products are: Wood pulp, Lumber, Sawlogs, and Simply shaped wood. They represent 20% of Chile's total biophysical exports (11.2 million tons) and 6.4% of its income (US$ 4.4 billion). Figure 18 shows its evolution since the 1960s.

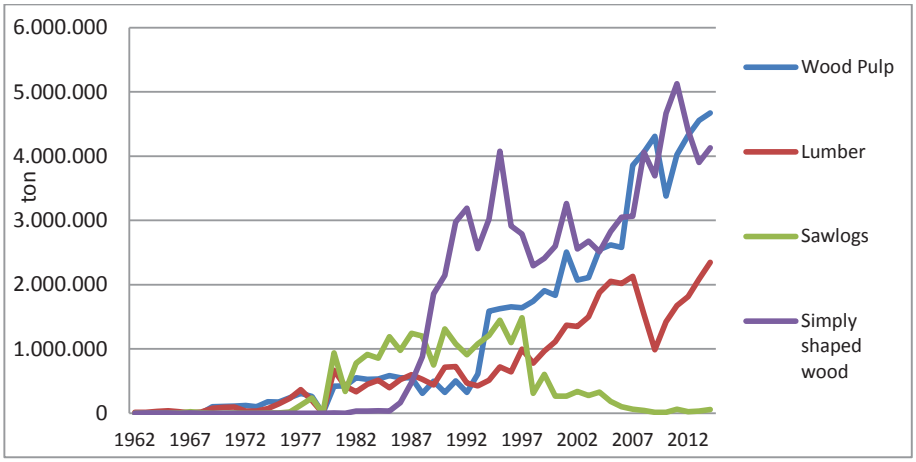

Figure 18: Chiles' four main wood related exportation products (in tonnes) between 1962 and 2014. *Source: Own Creation based on calculations based on SITC-Rev.1 data from ECLA-badecel and UN-comtrade. Wood pulp (SITC-Rev.1 2517), Lumber (SITC-Rev.1 2432), Sawlogs (SITC-Rev.1 2422), and Simply shaped or worked wood (SITC-Rev.1 6318).*

Chilean wood industry started developing during the 1970s, and grew strongly since the late 1980s. Sawlogs were important during the 1980s, but declined in the late 1990s, suggesting that national producers started processing more their products (stopped exporting "raw" sawlogs). As sawlogs are not a relevant export at the present, they will not be considered in the EUE analysis.

Wood Pulp (SICT Rev.1- 2517)					
Country	**1969-1979**	**1980s**	**1990s**	**2000s**	**2010-2014**
Argentina	35%	4%	2%	1%	1%
China	0%	16%	8%	28%	35%
Japan	2%	6%	13%	4%	2%
Rep. Of Korea	5%	7%	8%	9%	10%
Europe (1)	13%	24%	24%	24%	27%
other countries	45%	42%	45%	34%	24%
Total (ton)	**1.692.168**	**3.583.686**	**11.577.208**	**28.488.238**	**20.954.353**

Table 7: Chilean Wood Pulp exports by country. *Source: Own Creation based on data from SICT Rev.1 – 2517, from UN-Comtrade and ECLA-Badecel. Data for the 1960s is available since 1962, and data for 1979 is not available. Among "other countries" the most relevant are India, Venezuela, USA and Asian countries.*

Since the 2000s the main destinations of Wood Pulp are China and Europe (Germany, France, Italy, Netherlands and the U.K.). In this product it is also possible to see how the "centre" have move from diverse countries to be concentrated in China.

Lumber (SICT Rev.1- 2432)						
Country	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2010-2014**
USA	3%	1%	2%	16%	32%	20%
Argentina	50%	48%	22%	1%	0%	0%
China	0%	0%	0%	0%	5%	18%
Japan	0%	2%	0%	30%	9%	10%
Rep. Of Korea	0%	0%	0%	4%	3%	9%
Europe (1)	13%	8%	6%	5%	2%	0%
other countries	34%	41%	70%	44%	50%	43%
Total (ton)	**208.058**	**1.330.104**	**4.853.286**	**5.263.254**	**4.655.159**	**9.342.014**

Table 8: Chilean Lumber exports by country. *Source: Own Creation based on data from SICT Rev.1 – 2432, from UN-Comtrade and ECLA-Badecel. Data for the 1960s is available since 1962, and data for 1979 is not available. Among "other countries" we find principally the United Arab Emirates, Kuwait, Egypt and Saudi Arabia.*

Lumber is principally exported to USA, China and Korea. Argentina was the principal importer during the 1960s and 1970s, but thereafter its share decreased (same with wood pulp). USA increased its Chilean lumber imports since the 1990s.

Wood simply shaped or worked (SICT Rev.1- 6318)						
Country	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2010-2014**
Argentina	19%	8%	0%	0%	0%	0%
Japan	0%	0%	65%	93%	98%	94%
other countries	81%	92%	35%	6%	2%	6%
Total (ton)	**1.892**	**608**	**3.513.969**	**26.225.198**	**24.484.146**	**22.229.369**

Table 9: Chilean simply shaped or worked wood exports by country. *Source: Own Creation based on data from SICT Rev.1 – 6318, from UN-Comtrade and ECLA-Badecel. Data for the 1960s is available since 1962, and data for 1979 is not available.*

In the 1960s, important destinations of *simply worked wood* were Spain and Israel, while during the 1970s Venezuela. At the present *simply worked wood* is almost completely exported to Japan.

8. Imports from USA, China and Japan (2014)

Table 10: Chilean Imports from USA, China and Japan (2014)				
Country	**Volume (ton)**	**%**	**US$ 2014**	**%**
USA	11.457.107	23%	$14.305.572	20%
China	3.690.362	8%	$15.103.848	21%
Japan	846.995	2%	$2.361.205	3%
Sum (3)	**15.994.464**	**33%**	**31.770.625**	**44%**
Total Chilean imports	**49.033.708**	**100%**	**$72.343.624**	**100%**

Table 10: Chilean Imports from U.S.A, China and Japan in 2014 (volume and US$). *Source: Own Creation based on statistics from SITC-Rev.1 trade data from UN-Comtrade, ECLA-Badecel, and Chilean Central Bank.*

9. Imports from USA

After analysing the imports from USA between 2000 and 2014, I identified seven main products:

Fossil Fuels:

1. *Petroleum products* (SITC-Rev.1: 332)
2. *Coal, coke & briquettes* (SITC-Rev.1: 321)
3. *Gas*, natural and manufactured (SITC-Rev.1: 341)

Chemicals and related products:

4. *Inorganic Chemicals* (SITC-Rev.1: 514)
5. *Fertilizers* (manufactured) (SITC-Rev.1: 561)

Food products:

6. *Wheat* (SITC-Rev.1: 041)
7. *Maize* (SITC-Rev.1: 044)

Table 11: Chilean main imports from USA 2000-2014

Product	Volume (ton)	%	US$ (2014)	%
Petroleum	40.694.270	44%	$ 36.507.110	25,3%
Coal	17.324.978	19%	$ 1.547.121	1,1%
Gas	2.589.514	3%	$ 1.964.916	1,4%
Inorganic chemicals	3.954.061	4%	$ 1.573.564	1,1%
Fertilizers (manufactured)	3.035.379	3%	$ 1.479.542	1,0%
Wheat	4.100.466	4%	$ 1.284.692	0,9%
Maize	1.608.834	2%	$ 526.083	0,4%
Total (7 products)	**73.307.502**	**79%**	$ 44.883.027	**31%**
Total U.S.A	**92.619.365**	**100%**	$ 144.297.891	**100%**

Table 11: Principal Chilean imports from U.S.A between 2000 and 2014 in volume (tons) and constant US$ 2014. *Source: Own Creation based on SITC-Rev.1 trade data from UN-Comtrade, ECLA-Badecel, and Chilean Central Bank.*

Between 2000 and 2014 these seven products constituted 79% of Chile's total material imports from the USA (31% in monetary terms). The main imports from USA are fossil fuels (66% in physical), followed by chemical products (7%) and wheat and maize (6%).

10. Imports from China

Between 2000 and 2014 the main products Chile imported from China were:

Manufactured Goods:

1. *Steel related products*: as steel sheets, bars, plates, tubes and pipes (SITC-Rev.1: 673, 674 and 678)
2. *Clay and refractory construction materials* (SITC-Rev.1: 662)
3. *Clothing* (SITC-Rev.1: 841)
4. *Perambulator, toys and sport products* (SITC-Rev.1: 894)

Chemicals and related products:

5. *Inorganic Chemicals* (SITC-Rev.1: 514)
6. *Fertilizers* (manufactured) (SITC-Rev.1: 561)

Table 12: Chilean main imports from China 2000-2014				
Product	**Volume (ton)**	**%**	**US$ (2014)**	**%**
Steel Products	4.850.959	22%	$ 4.238.493	4%
Inorganic chemicals	1.156.998	5%	$ 480.457	0,4%
Fertilizers (manufactured)	2.041.894	9%	$ 861.665	0,8%
Construction Materials (clay)	924.422	4%	$ 560.446	0,5%
Perambulator, toys and sport products	1.019.439	5%	$ 5.289.156	5%
Clothing	874.418	4%	$ 20.360.787	18%
Total (6 products)	**10.868.129**	**48%**	**$ 31.791.005**	**28%**
Total China	**22.540.934**	**100%**	**$ 114.520.406**	**100%**

Table 12: Principal Chilean imports from China between 2000 and 2014 in volume (tons) and constant US$ 2014. *Source: Own Creation based on SITC-Rev.1 trade data from UN-Comtrade, ECLA-Badecel, and Chilean Central Bank.*

11. Imports from Japan

Between 2000 and 2014 Chile imported principally eight products from Japan:

Fossil Fuels and Raw Material:

1. *Petroleum* (SITC-Rev.1: 332)
2. *Iron waste*: slag, dross, scaling and similar waste (SITC-Rev.1: 276)

Machinery and Transport Equipment:

3. *Machinery:* construction, glass-working, mining, pulp-mill, printing and bookbinding, and food-processing machines, pumps, centrifuges, mechanical handling equipment, heating and cooling machines, etc. (SITC-Rev.1: 718 and 719)
4. *Motorized Vehicles*: as cars, trucks, ships, boats (SITC-Rev.1: 732 and 735)

Manufactured Goods:

5. *Steel Products:* as steel plates, sheets, ingots, bars, tubes, pipes, etc. (SITC-Rev.1: 674, 672, 673 and 678)
6. *Rubber Articles:* tyres, tubes, pharmaceutical articles, transmission belts, etc. (SITC-Rev.1: 629)
7. *Cement and Lime* (SITC-Rev.1: 661)

Chemicals and related products:

8. *Inorganic Chemicals* (SITC-Rev.1: 514)

Table 13: Chilean main imports from Japan 2000-2014				
Products	**Volume (ton)**	**%**	**US$ (2014)**	**%**
Petroleum products	3.939.228	29%	$ 3.795.519	12%
Iron Waste	374.442	3%	$ 11.319	0,04%
Machinery	335.750	3%	$ 3.238.211	10%
Steel Products	494.525	4%	$ 489.687	1%
Rubber Articles	319.916	2%	$ 1.950.532	6%
Cement and Lime	1.344.886	10%	$ 87.620	0,3%
Motorized Vehicles (road and ships)	1.425.875	10%	$ 16.331.951	51%

Inorganic Chemicals	5.086.288	37%	$	551.085	2%
Total (8 products)	**13.320.911**	**98%**	**$**	**26.455.923**	**82%**
Total Japan	**13.638.459**	**100%**	**$**	**32.324.080**	**100%**

Table 13: Principal Chilean imports from Japan between 2000 and 2014 in volume (tons) and constant US$ 2014. *Source: Own Creation based on SITC-Rev.1 trade data from UN-Comtrade, ECLA-Badecel, and Chilean Central Bank.*